Chemical Data Analysis

Prepared for

Harford County Department of Public Works
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June 2005
EA Project No. 14100.05

INTRODUCTION

Harford County Department of Public Works (DPW) compiled chemical data from stormwater samples collected from two stations (001 and 002) in Bel Air, Maryland in an Access database for the years 1998 through 2004. Station 001 (downstream station) is located upstream at Tollgate Road and station 002 (upstream station) is located downstream from Brentwood Park Drive at the outfall of a storm water management facility. Stormflow samples were collected during storm events and baseflow samples were collected monthly. Continuous Temperature, pH, velocity, flow and precipitation were recorded at the downstream station for baseflow and stormflow events. Continuous temperature, pH, velocity, flow were recorded at the outfall station during stormflow events and monthly baseflow sampling. A summary of each sampling event in 2004 is presented in Appendix A.

CHEMICAL DATA ANALYSIS

EA Engineering was contracted to conduct comparisons and statistical trend analyses for samples collected from 1998-2004 the following water quality parameters.

- 5 Day Biological Oxygen Demand (BOD5)
- Total Kjeldahl Nitrogen (TKN)
- Total Phosphorus (TP)
- Total Copper (Cu)
- Total Cadmium (Cd)
- Total Zinc (Zn)
- Total Lead (Pb)
- Total Suspended Solids (TSS)
- Nitrate plus Nitrite (NO23)
- Total Petroleum Hydrocarbons (TPH)
- Total Phenols (Phenols)
- Fecal Coliform (Fecals)

To compare the water quality parameters between years and to conduct the statistical analyses, land use data from each station was collected, the runoff coefficients were estimated, and precipitation data was averaged. Using these data, an event mean concentration (EMC) was calculated and compared to Maryland Department of the Environment (MDE) water quality criteria, NPDES data from Maryland and Nationwide Urban Runoff Program (NURP) data. Finally, statistical comparisons were conducted to determine a correlation between stations using benthic data collected by Harford County DPW and pollutant loads were determined for each station and compared to adjacent watershed in Maryland.

Land Use

The existing land use codes, land use categories and land use acreage for each station is presented in Table 1. The total drainage area for station 001 is 169.09 acres and the drainage area for station 002 is 79.02 acres (Figure 1).

Table 1
Land Use Code, Land Use Category and Land Use Acreage

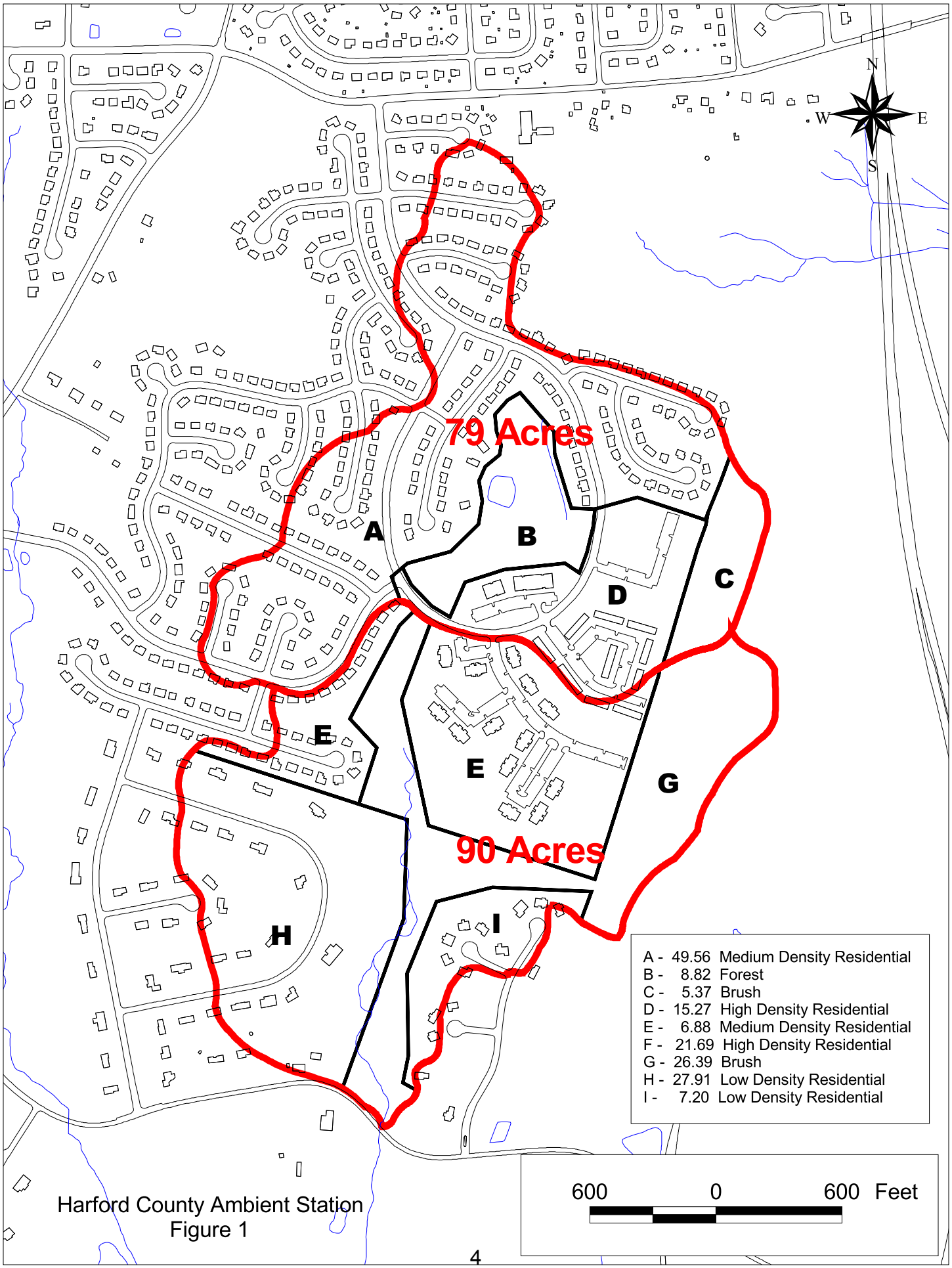
Station[(a)]	Land Use Code	Land Use Category	Land Use	Land Use Acreage
001	11	Residential	Low Density Residential	35.11
001	12	Residential	Medium Density Residential	56.44
001	13	Residential	High Density Residential	36.96
002	12	Residential	Medium Density Residential	49.56
002	13	Residential	High Density Residential	15.27
002	18	Urban	Open Urban	14.19

(a) Station 001 is designated as the instream and station 002 is designated as the outfall.

Estimation of Runoff Coefficients

The runoff coefficient from the downstream station 001 was determined empirically by a regression analysis between measured flow data and precipitation. The empirical runoff coefficient for 001 was determined to be 0.31.

For station 002, there is insufficient flow data for which to determine the runoff coefficient empirically. Therefore, the runoff coefficients for station 002 were estimated based on the impervious area within each zoning category. Information regarding each zoning category was obtained from the County. The runoff coefficient for each zoning category was estimated using Equation 3 on page 5-16 of the "*Guidance Manual for the Preparation of Part 2 of the NPDES Permit Applications for Discharges from Municipal Separate Storm Sewer Systems*", 1992.



Harford County Ambient Station
Figure 1

The runoff coefficient (Rv_i) is directly related to imperviousness and land use. The following equation was used to estimate average runoff coefficients for percent imperviousness. The land use code, impervious cover and calculated runoff coefficients are listed in Table 2. Using this method, the runoff coefficient for 002 was estimated to be 0.29.

Equation 3

$$Rv_i = 0.05 + 0.009*I$$

Where: Rv_i = Runoff coefficient
I = Imperviousness area

Table 2
Land Use Code, Impervious Cover and Runoff Coefficient
Station 002

Land Use Code	Land Use	Impervious Cover (%)	Runoff Coefficient (Rv_i)
11	Low Density Residential	14.3	0.1787
12	Medium Density Residential	27.8	0.3002
13	High Density Residential	40.9	0.4181
18	Open Urban	8.6	0.1274

Precipitation

The daily rainfall totals for 2004 are presented in Table 3. The monthly rainfall totals for 1998-2004 are presented in Appendix A. The rain gauge is located at the instream station and the measurements are recorded by the SIGMA. During periods where the SIGMA was not recording data, precipitation data from Baltimore/Washington International Airport was substituted. The total rainfall measured by the SIGMA for the year 2004 was 46.61 inches.

Table 3
2004 Daily Rainfall Totals (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	**0.00**	0.10	0.00	1.11	0.00	0.08	0.02	0.22	0.00	0.00	0.00	0.83
2	**0.17**	0.03	0.05	0.82	0.39	0.10	0.00	0.00	0.00	0.04	0.00	0.00
3	**0.00**	0.93	0.00	0.02	0.65	0.01	0.00	0.00	0.00	0.01	0.00	0.00
4	**0.00**	0.00	0.00	0.29	0.00	0.05	0.14	0.03	0.00	0.00	0.96	0.00
5	**0.34**	0.00	0.00	0.00	0.01	1.89	0.43	0.01	0.00	0.00	0.00	0.00
6	0.00	2.03	1.22	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.01	0.11	0.00	0.04	0.00	0.55	0.00	0.00	0.00	0.00	0.34
8	0.00	0.00	0.04	0.14	0.00	0.00	0.01	0.00	0.23	0.00	0.00	0.01
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.61
10	0.00	0.00	0.04	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.36
11	0.00	0.00	0.00	0.03	0.00	0.74	0.00	0.85	0.00	0.00	0.00	0.06
12	0.00	0.00	0.00	1.14	0.00	0.00	1.96	0.77	0.00	0.00	1.29	0.00
13	0.00	0.00	0.00	0.37	0.00	0.00	0.01	0.14	0.00	0.01	0.06	0.02
14	**0.00**	**0.00**	0.00	0.13	0.00	0.98	0.08	0.31	0.00	1.14	0.00	0.00
15	**0.00**	**0.00**	0.00	0.00	0.35	0.00	0.00	0.00	0.07	0.22	0.00	0.00
16	**0.00**	**0.00**	0.48	0.00	0.02	0.00	0.00	0.02	0.01	0.17	**0.00**	0.00
17	**0.10**	0.00	0.01	0.00	0.06	0.11	0.03	0.00	0.12	0.01	**0.00**	0.00
18	**0.25**	0.00	0.19	0.00	0.07	0.00	0.40	0.00	1.82	0.00	**0.00**	0.00
19	**0.00**	0.00	0.19	0.00	0.09	0.00	0.00	0.04	0.00	0.36	**0.00**	0.04
20	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.11	**0.28**	0.00
21	0.00	0.00	0.01	0.00	0.37	0.00	0.00	0.02	0.00	0.10	**0.00**	0.00
22	0.00	0.00	0.00	0.00	0.00	0.11	0.04	0.00	0.00	0.03	0.01	0.00
23	0.00	0.00	0.00	0.62	0.00	0.00	0.34	0.00	0.00	0.01	0.00	**1.03**
24	0.02	0.10	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.39	**0.00**
25	0.00	0.00	0.01	0.00	0.74	0.07	0.00	0.00	0.00	0.00	0.04	**0.00**
26	0.00	0.00	0.00	0.62	0.06	0.00	0.05	0.00	0.00	0.00	0.00	**0.00**
27	0.00	0.00	0.16	0.02	0.00	0.00	3.00	0.00	0.01	0.00	0.21	**0.00**
28	0.00	0.00	0.00	0.00	0.03	0.00	0.10	0.00	3.74	0.00	2.02	**0.00**
29	0.01	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.02	0.00	**0.00**
30	0.00		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.07	0.00
31	0.00		0.09		0.10		0.00	0.00		0.00		0.00
Total	0.9	3.2	2.62	5.31	2.98	4.46	7.17	2.42	6.32	2.6	5.33	3.3

Note: Bold values indicate days where the precipitation gauge was malfunctioning, so precipitation data from BWI was substituted.

Annual Rainfall = 46.61 inches

Event Mean Concentration

The continuous flow data and water quality data were used to estimate an event mean concentration (EMC) for each parameter during each stormflow and baseflow event in the year 2004 at stations 001 and 002. The EMCs were based on storm water samples collected during the rising limb, the peak, and the falling limb of the storm. Water quality data was evaluated using three substitution methods for results below the detection limit (DL): (1) zero, (2) one-half of the DL, and (3) the DL. The results are presented in Tables 4 through 7. Monthly EMCs for the year 2004 are presented in Tables 8 and 9. The EMCs for the baseflow and stormflow sampling events from each station is graphed in Figures 2 through 6. The EMC for each parameter was estimated using the formula below:

$$EMC = \frac{\sum C_i \times V_i}{\sum V_i}$$

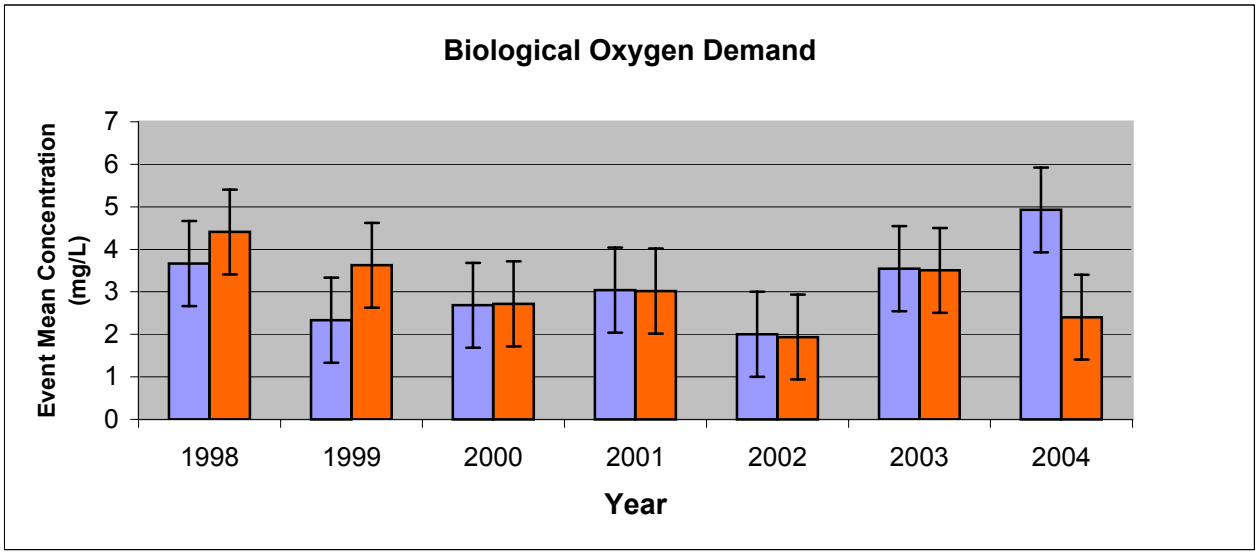
$$V_i = \sum_{t-I/2}^{t+I/2} Q_t \Delta t$$

where:

- EMC = event mean concentration
- C_i = concentration of the ith sample in the storm
- V_i = storm flow volume associated with the ith sample in the storm
- Q_t = the volume flow rate at time t
- □t = the interval between flow measurements (typically 5-minutes for site 001)
- I = the time interval between consecutive samples

Existence of Acute or Chronic Conditions

The EMCs of copper, lead and zinc stormflow and baseflow samples for stations 001 and 002 were compared to the Maryland Department of the Environment (MDE) acute and chronic freshwater water quality criteria for ambient surface waters. There was low frequency of detects for cadmium in the stormflow and baseflow samples for both stations. The estimated EMCs for cadmium were at or below zero, therefore, the EMCs were not used in the comparisons. The acute and chronic criteria are listed in Table 10. The data for the year 2004 is presented in Figure 7 and the comprehensive data for the years 1998-2004 is presented in Figures 8 through 11. The EMCs compared were calculated using one half of the detection limit (DL) for concentrations less than the DL.



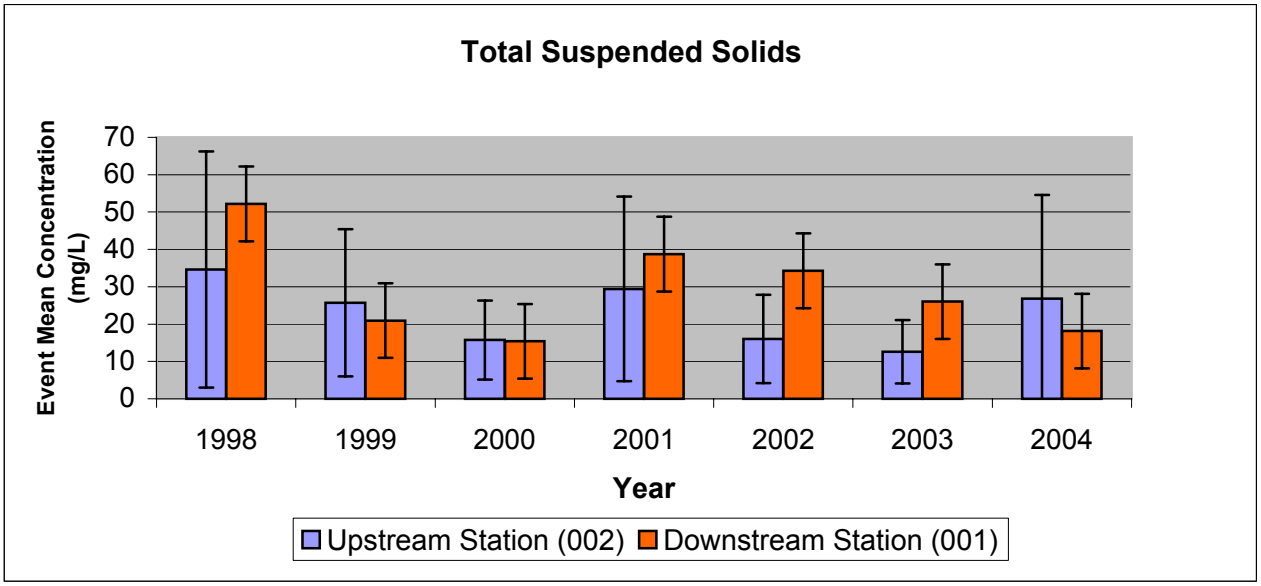


Figure 2. Event Mean Concentrations (EMCs) of biological oxygen demand (BOD5) and total suspended solids (TSS) data. The upstream station (outfall) is a tributary to Winters Run at Brentwood Park Drive, and the downstream station (instream) is a tributary to Winters Run at Tollgate Road. The EMCs were calculated based on analysis results of discrete samples collected from baseflow and stormflow sampling events between April 1998 and December 2004. Data presented is one half of the detection limit (DL) for concentrations less than the DL. The error bars represent the confidence intervals.

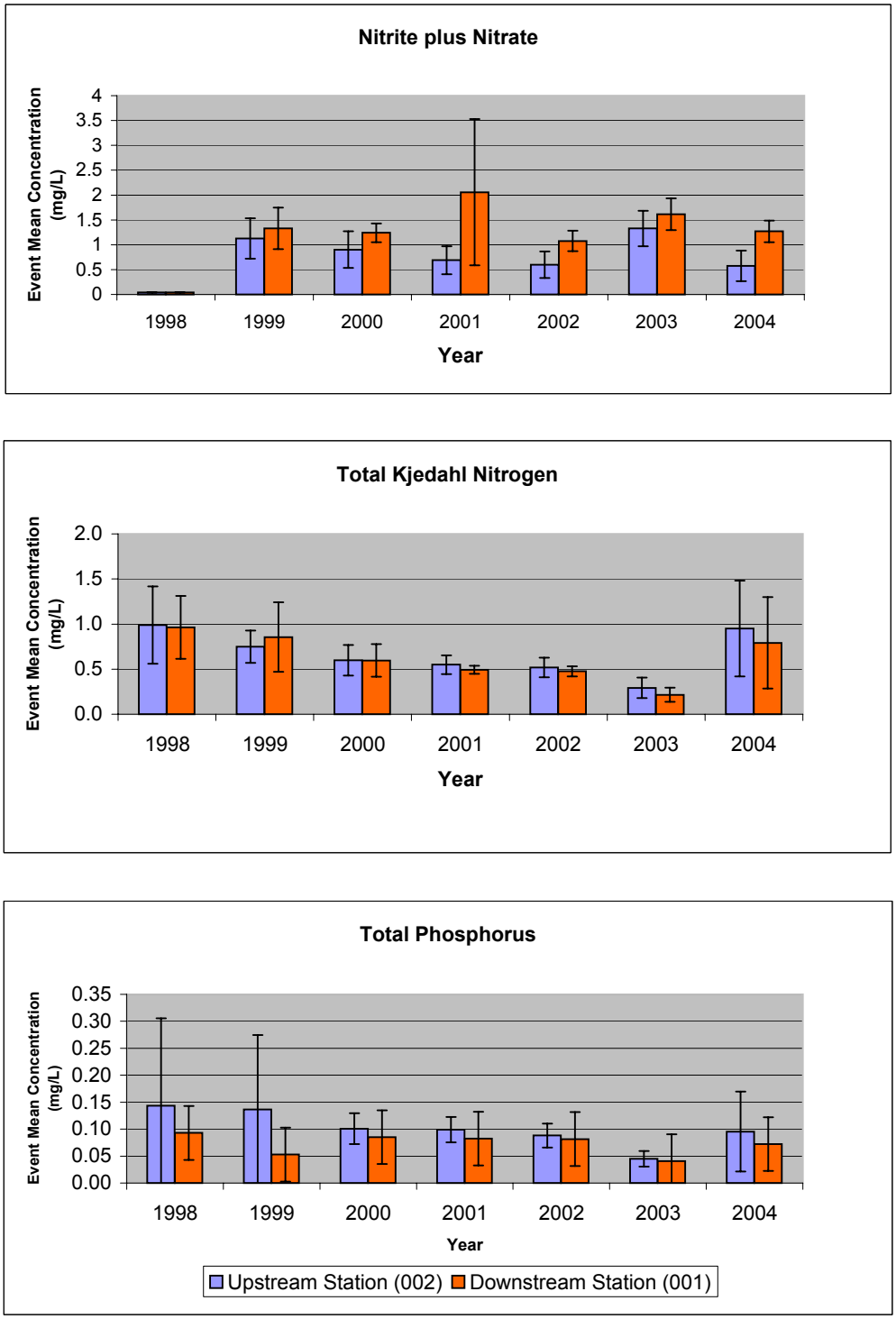
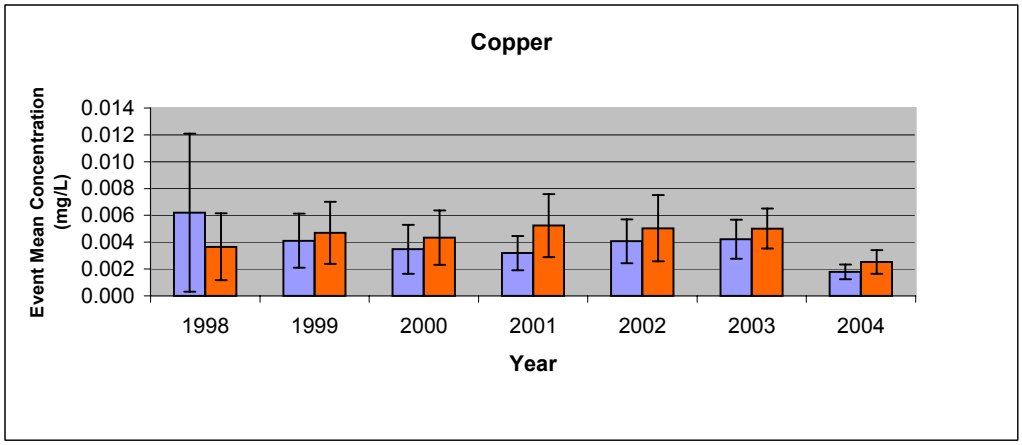
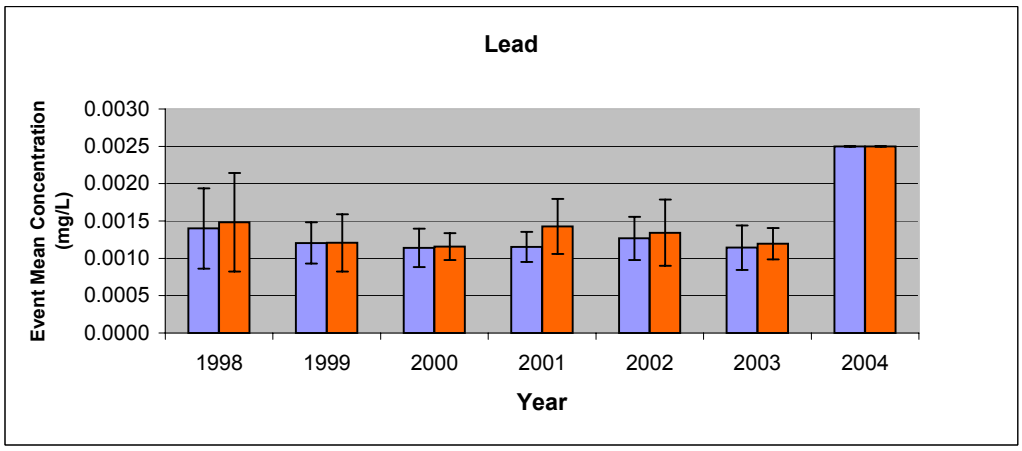


Figure 3. Event Mean Concentrations (EMCs) of nitrite plus nitrate (NO2NO3), total kjeldahl nitrogen (TKN) and total phosphorus baseflow and stormflow data. The upstream station (outfall) is a tributary to Winters Run at Brentwood Park Drive, and the downstream station (instream) is a tributary to Winters Run at Tollgate Road. The EMCs were calculated based on analysis results of discrete samples collected from baseflow and stormflow sampling events between April 1998 and December 2004. Data presented is one half of the detection limit (DL) for concentrations less than the DL. The error bars represent the confidence intervals.





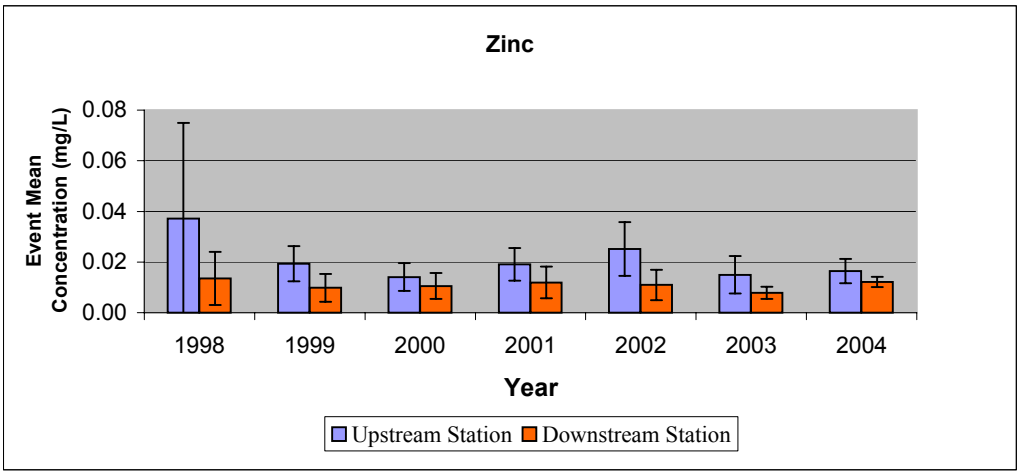


Figure 4. Event Mean Concentrations (EMCs) of copper (Cu), lead (Pb) and zinc (Zn) baseflow and stormflow data. The upstream station (outfall) is a tributary to Winters Run at Brentwood Park Drive, and the downstream station (instream) is a tributary to Winters Run at Tollgate Road. The EMCs were calculated based on analysis results of discrete samples collected from baseflow and stormflow sampling events between April 1998 and December 2004. Data presented is one half of the detection limit (DL) for concentrations less than the DL. The error bars represent the confidence intervals.

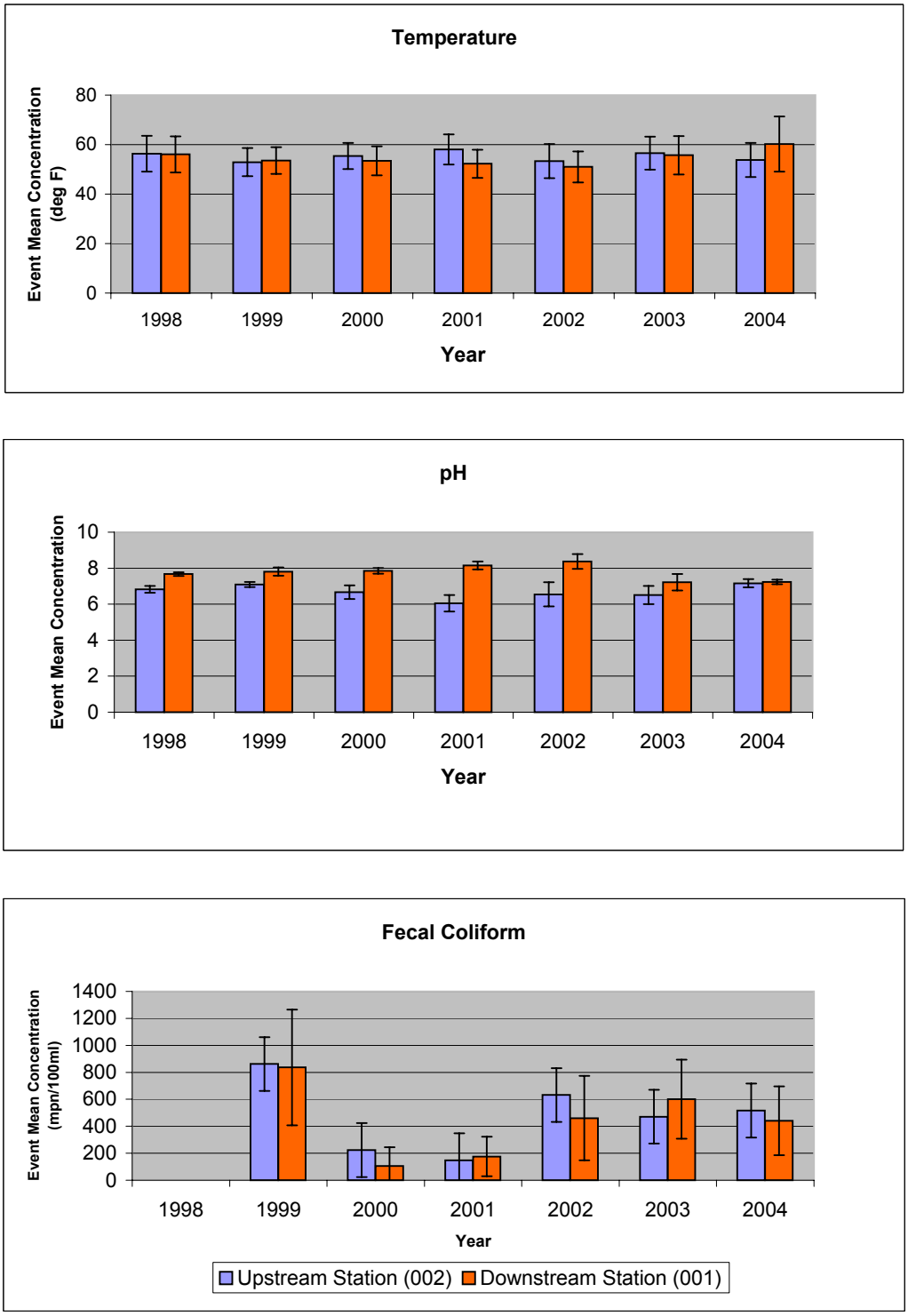
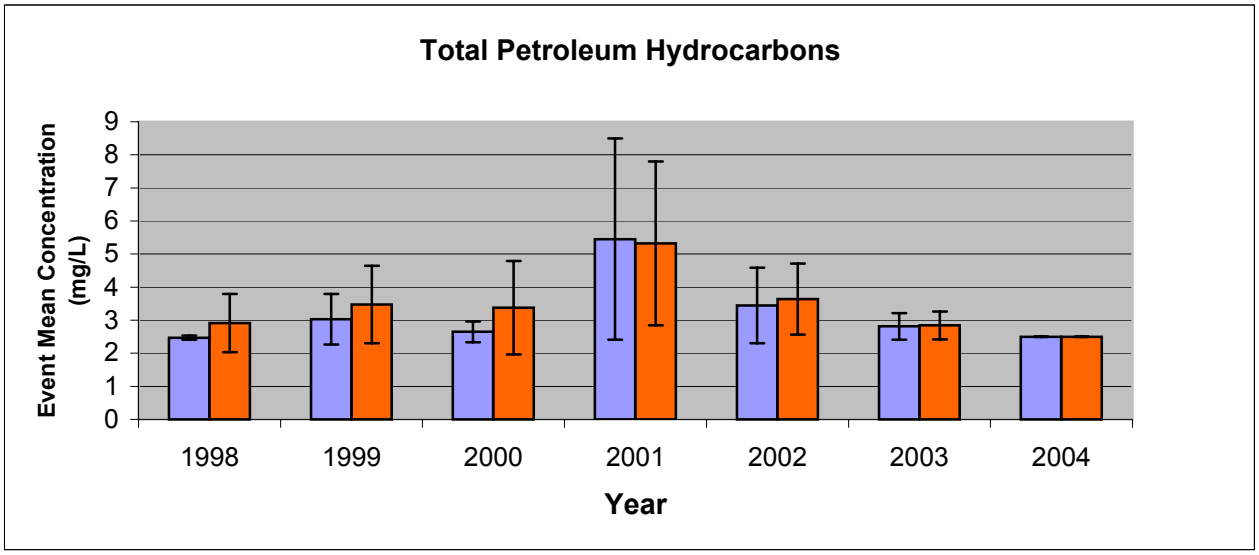


Figure 5. Event Mean Concentrations (EMCs) of temperature, pH and fecal coliform baseflow and stormflow data. The upstream station (outfall) is a tributary to Winters Run at Brentwood Park Drive, and the downstream station (instream) is a tributary to Winters Run at Tollgate Road. The EMCs were calculated based on analysis results of discrete samples collected from baseflow and stormflow sampling events between April 1998 and December 2004. Fecal coliform samples were not collected and analyzed in 1998. The error bars represent the confidence intervals.



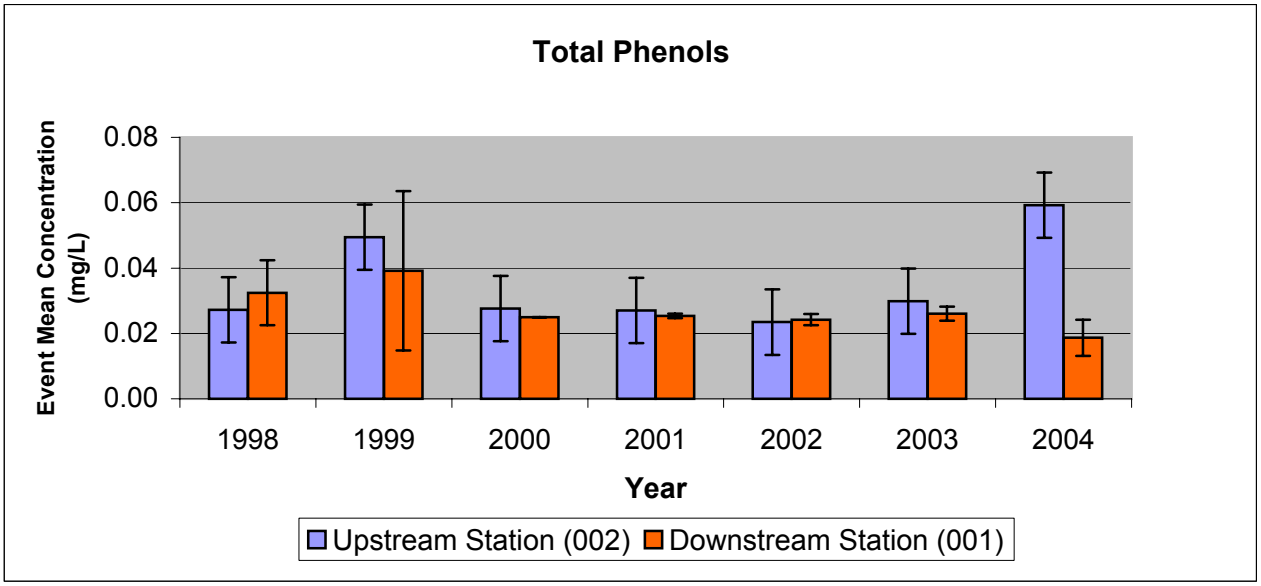


Figure 6. Event Mean Concentrations (EMCs) of total petroleum hydrocarbons (TPH) and total phenols baseflow and stormflow data. The upstream station (outfall) is a tributary to Winters Run at Brentwood Park Drive, and the downstream station (instream) is a tributary to Winters Run at Tollgate Road. The EMCs were calculated based on analysis results of discrete samples collected from baseflow and stormflow sampling events between April 1998 and December 2004. Data presented is one half of the detection limit (DL) for concentrations less than the DL. The error bars represent the confidence intervals.

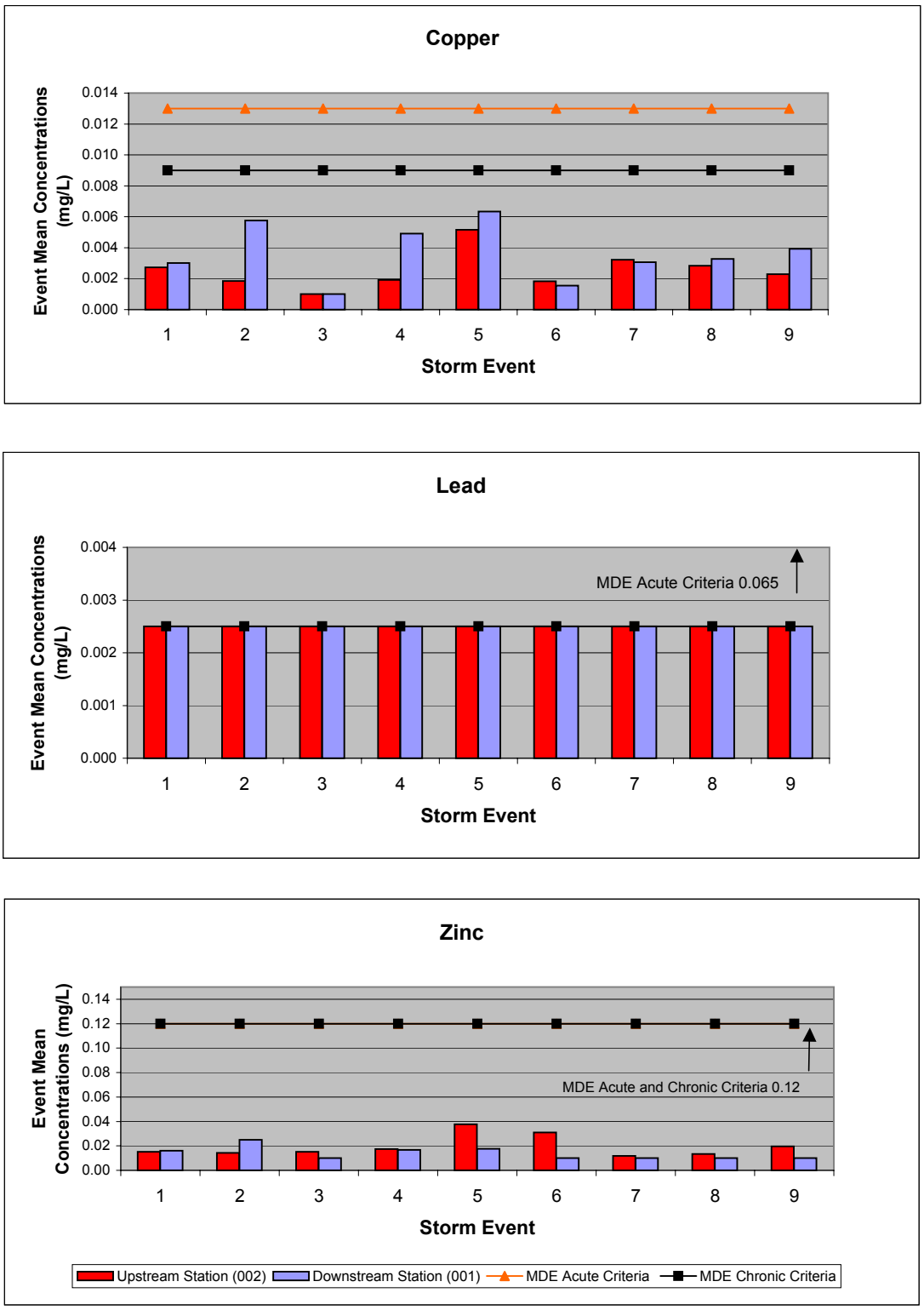


Figure 7. 2004 Event Mean Concentrations (EMCs) of copper (Cu) , lead (Pb) and zinc (Zn) stormflow data from the upstream (outfall) and downstream station (instream) compared against the Maryland Department of the Environment (MDE) acute and chronic freshwater water quality criteria for ambient surface waters. Data presented is on half of the detection limit (DL) for concentrations less than the DL.

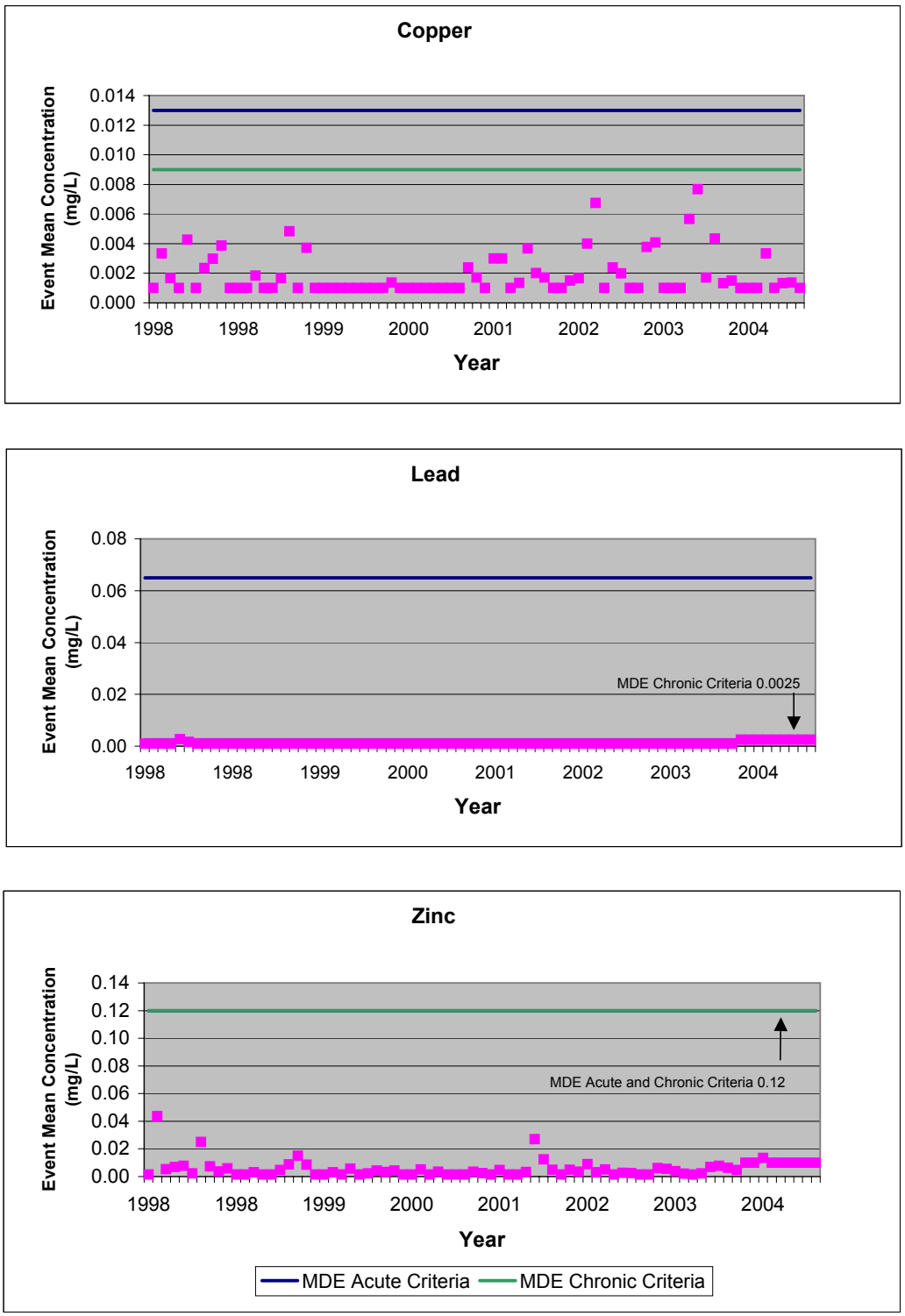
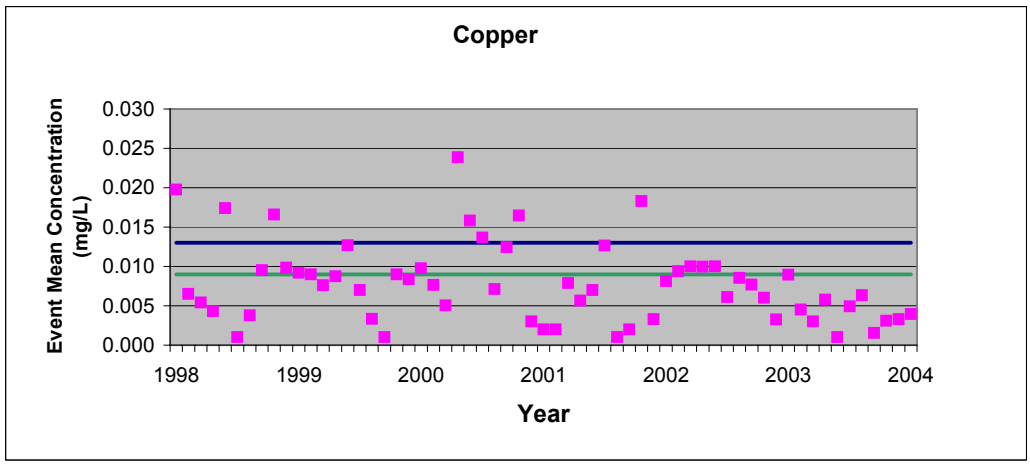
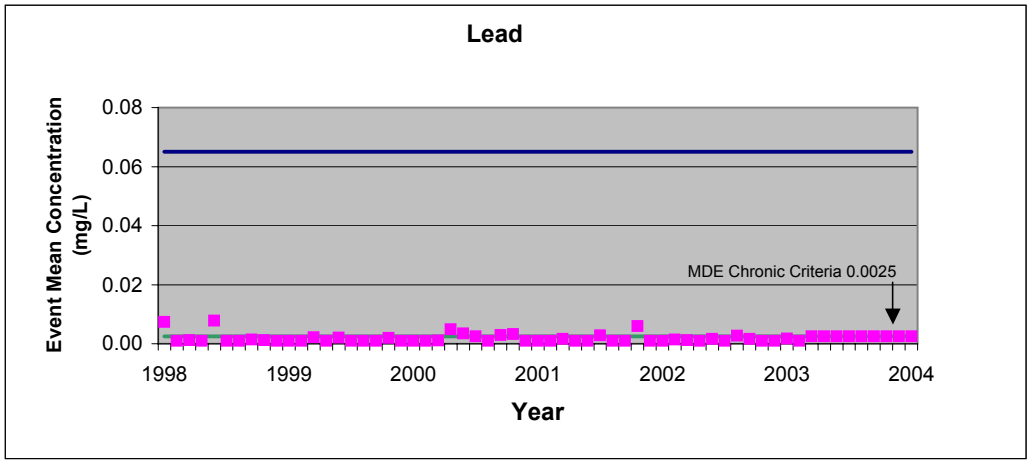


Figure 8. 1998 - 2004 Event Mean Concentrations (EMCs) of copper (Cu) , lead (Pb) and zinc (Zn) baseflow data from the downstream station (instream) compared against the Maryland Department of the Environment (MDE) acute and chronic freshwater water quality criteria for ambient surface waters. Data presented is on half of the detection limit (DL) for concentrations less than the DL.





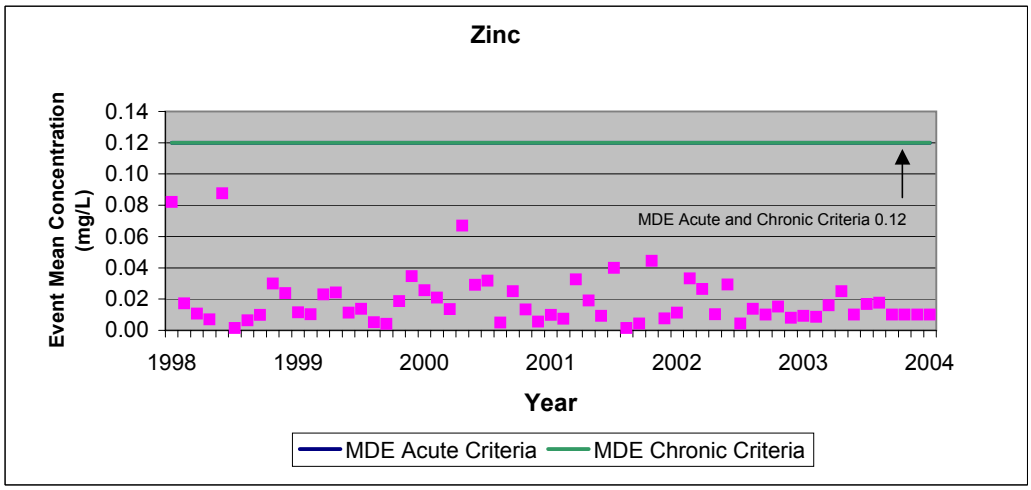
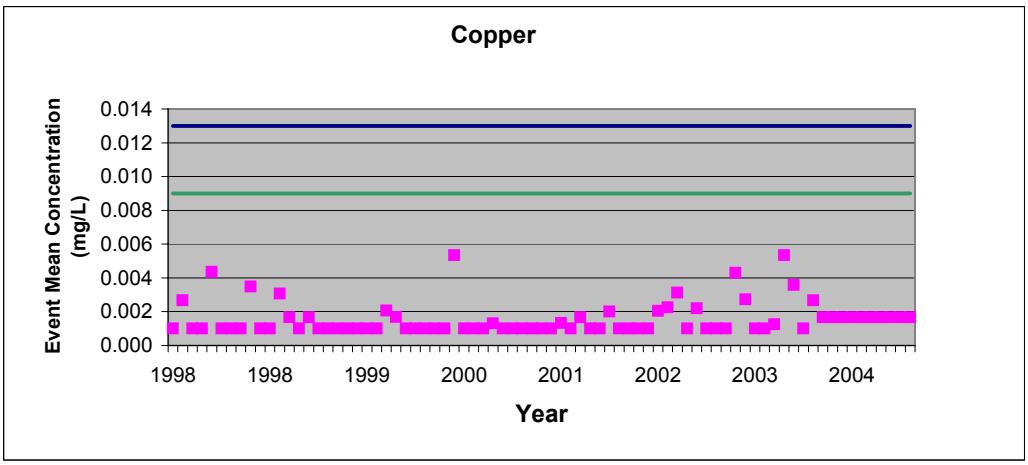
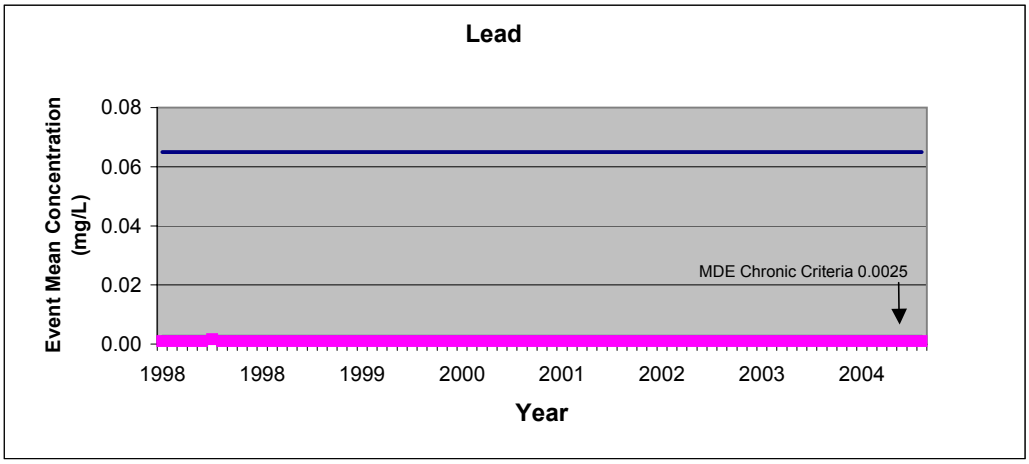


Figure 9. 1998 - 2004 Event Mean Concentrations (EMCs) of copper (Cu) , lead (Pb) and zinc (Zn) stormflow data from the downstream station (instream) compared against the Maryland Department of the Environment (MDE) acute and chronic freshwater water quality criteria for ambient surface waters. Data presented is on half of the detection limit (DL) for concentrations less than the DL.





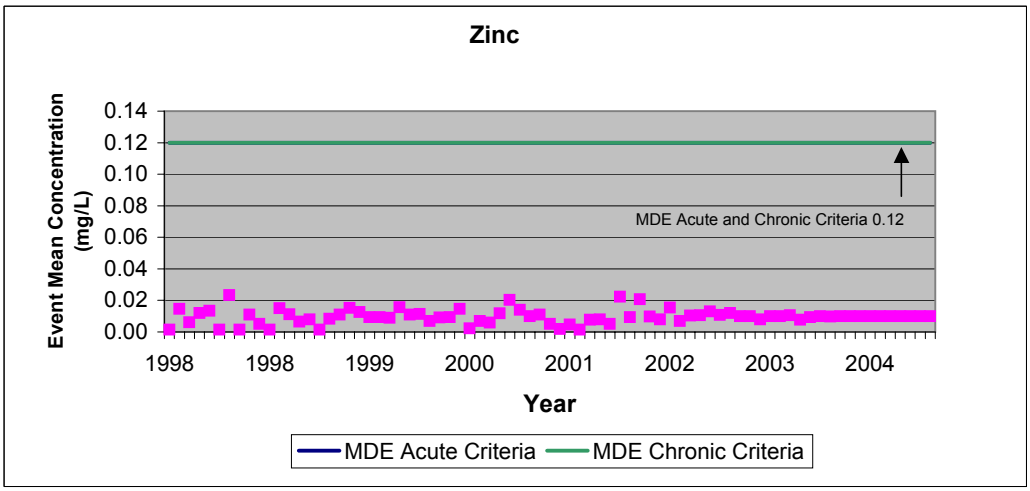


Figure 10. 1998 - 2004 Event Mean Concentrations (EMCs) of copper (Cu) , lead (Pb) and zinc (Zn) baseflow data from the upstream station (outfall) compared against the Maryland Department of the Environment (MDE) acute and chronic freshwater water quality criteria for ambient surface waters. Data presented is on half of the detection limit (DL) for concentrations less than the DL.

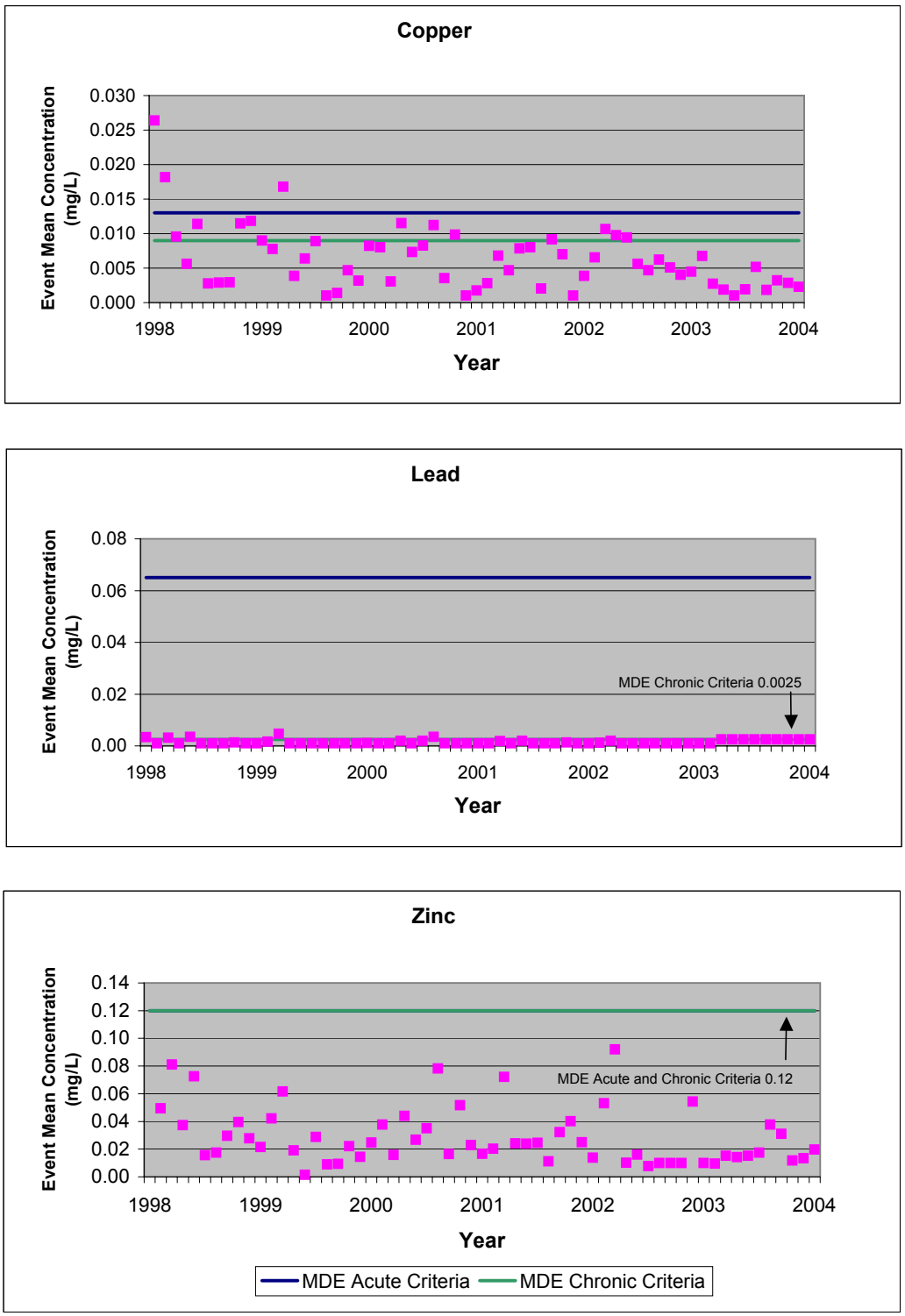


Figure 11. 1998 - 2004 Event Mean Concentrations (EMCs) of copper (Cu) , lead (Pb) and zinc (Zn) stormflow data from the upstream station (outfall) compared against the Maryland Department of the Environment (MDE) acute and chronic freshwater water quality criteria for ambient surface waters. Data presented is on half of the detection limit (DL) for concentrations less than the DL.

Table 4. 2004 Baseflow Event Mean Concentrations (EMCs)
Station 001

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1/29/2004	0	0	2.27	0.00	0.00	0.0000	0.001	0.000	0.000	0.0	0.02	33.1	7.37	1
2/26/2004	0	0	1.97	0.00	0.01	0.0000	0.000	0.000	0.000	0.0	0.03	35.4	7.18	18
3/24/2004	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	47.4	7.64	15
4/22/2004	0	1	1.50	0.33	0.09	0.0000	0.000	0.000	0.007	0.0	0.01	58.8	7.65	177
5/4/2004	1	5	1.40	0.00	0.02	0.0000	0.000	0.000	0.000	0.0	0.01	63.5	7.23	117
6/24/2004	0	5	1.20	2.90	0.02	0.0000	0.003	0.000	0.000	0.0	0.02	65.2	7.41	393
8/26/2004	0	3	1.30	0.00	0.01	0.0000	0.000	0.000	0.000	0.0	0.03	66.8	7.57	80
9/21/2004	0	1	1.13	0.00	0.03	0.0000	0.001	0.000	0.000	0.0	0.02	56.8	7.38	110
11/2/2004	0	1	0.78	0.00	0.01	0.0000	0.001	0.000	0.000	0.0	0.00	54.1	7.39	17
11/30/2004	0	0	1.47	0.00	0.01	0.0000	0.000	0.000	0.000	0.0	0.00	45.2	6.82	190

Baseflow EMCs (mg/L) were calculated from data using zero for concentrations less than the detection limit (DL).

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1/29/2004	1	1	2.27	0.10	0.01	0.0003	0.002	0.003	0.010	2.5	0.02	33.1	7.37	1
2/26/2004	1	1	1.97	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.03	35.4	7.18	18
3/24/2004	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	47.4	7.64	15
4/22/2004	1	2	1.50	0.40	0.09	0.0003	0.001	0.003	0.013	2.5	0.01	58.8	7.65	177
5/4/2004	1	5	1.40	0.10	0.02	0.0003	0.001	0.003	0.010	2.5	0.01	63.5	7.23	117
6/24/2004	1	5	1.20	2.90	0.02	0.0003	0.003	0.003	0.010	2.5	0.02	65.2	7.41	393
8/26/2004	1	3	1.30	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.03	66.8	7.57	80
9/21/2004	1	2	1.13	0.10	0.03	0.0003	0.001	0.003	0.010	2.5	0.02	56.8	7.38	110
11/2/2004	1	2	0.78	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.01	54.1	7.39	17
11/30/2004	1	1	1.47	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.01	45.2	6.82	190

Baseflow EMCs (mg/L) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 4 (continued). 2004 Baseflow Event Mean Concentrations (EMCs)
Station 001

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1/29/2004	2	3	2.27	0.20	0.01	0.0005	0.002	0.005	0.020	5.0	0.02	33.1	7.37	2
2/26/2004	2	3	1.97	0.20	0.01	0.0005	0.002	0.005	0.020	5.0	0.03	35.4	7.18	18
3/24/2004	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	47.4	7.64	15
4/22/2004	2	2	1.50	0.47	0.09	0.0005	0.002	0.005	0.020	5.0	0.01	58.8	7.65	177
5/4/2004	2	5	1.40	0.20	0.02	0.0005	0.002	0.005	0.020	5.0	0.01	63.5	7.23	117
6/24/2004	2	5	1.20	2.90	0.02	0.0005	0.004	0.005	0.020	5.0	0.02	65.2	7.41	393
8/26/2004	2	3	1.30	0.20	0.01	0.0005	0.002	0.005	0.020	5.0	0.03	66.8	7.57	80
9/21/2004	2	3	1.13	0.20	0.03	0.0005	0.002	0.005	0.020	5.0	0.02	56.8	7.38	110
11/2/2004	2	3	0.78	0.20	0.01	0.0005	0.002	0.005	0.020	5.0	0.01	54.1	7.39	17
11/30/2004	2	3	1.47	0.20	0.01	0.0005	0.002	0.005	0.020	5.0	0.01	45.2	6.82	190

Baseflow EMCs (mg/L) were calculated from data using the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 5. 2004 Stormflow Event Mean Concentrations (EMCs)
Station 001

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
3/16/2004	1	16	1.52	0.00	0.05	0.0000	0.003	0.000	0.012	0.0	0.02	38.1	6.88	425
6/4/2004	6	89	0.73	2.49	0.41	0.0000	0.006	0.000	0.020	0.0	0.03	61.0	7.19	-999
6/10/2004	0	9	1.38	1.04	0.09	0.0000	0.000	0.000	0.000	0.0	0.04	70.6	7.41	877
6/22/2004	3	31	1.33	2.83	0.08	0.0000	0.005	0.000	0.010	0.0	0.04	67.9	7.42	918
9/8/2004	1	92	1.51	1.82	0.31	0.0000	0.006	0.000	0.013	0.0	0.00	70.8	7.02	1600
9/28/2004	2	1	1.07	0.69	0.01	0.0000	0.001	0.000	0.000	0.0	0.03	64.5	7.11	812
11/4/2004	11	6	0.53	0.00	0.04	0.0000	0.003	0.000	0.000	0.0	0.01	48.9	7.01	1488
11/12/2004	6	6	0.71	0.00	0.03	0.0000	0.003	0.000	0.000	0.0	0.01	46.1	6.88	693
12/23/2004	0	54	1.07	1.03	0.05	0.0000	0.004	0.000	0.000	0.0	0.00	42.6	6.83	0

Stormflow EMCs (mg/L) were calculated from data using zero for concentrations less than the detection limit (DL).

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
3/16/2004	1	16	1.52	0.10	0.05	0.0003	0.003	0.003	0.016	2.5	0.02	38.1	6.88	425
6/4/2004	6	89	0.73	2.49	0.41	0.0003	0.006	0.003	0.025	2.5	0.03	61.0	7.19	-999
6/10/2004	1	9	1.38	1.05	0.09	0.0003	0.001	0.003	0.010	2.5	0.04	70.6	7.41	877
6/22/2004	3	31	1.33	2.83	0.08	0.0003	0.005	0.003	0.017	2.5	0.04	67.9	7.42	918
9/8/2004	2	92	1.51	1.82	0.31	0.0003	0.006	0.003	0.018	2.5	0.01	70.8	7.02	1600
9/28/2004	2	2	1.07	0.69	0.01	0.0003	0.002	0.003	0.010	2.5	0.03	64.5	7.11	812
11/4/2004	11	6	0.53	0.10	0.04	0.0003	0.003	0.003	0.010	2.5	0.01	48.9	7.01	1488
11/12/2004	6	6	0.71	0.10	0.03	0.0003	0.003	0.003	0.010	2.5	0.01	46.1	6.88	693
12/23/2004	1	54	1.07	1.07	0.06	0.0003	0.004	0.003	0.010	2.5	0.01	42.6	6.83	0

Stormflow EMCs (mg/L) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 5 (continued). 2004 Stormflow Event Mean Concentrations (EMCs)
Station 001

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
3/16/2004	2	16	1.52	0.20	0.05	0.0005	0.003	0.005	0.020	5.0	0.02	38.1	6.88	425
6/4/2004	6	89	0.73	2.49	0.41	0.0005	0.006	0.005	0.029	5.0	0.03	61.0	7.19	-999
6/10/2004	2	9	1.38	1.07	0.09	0.0005	0.002	0.005	0.020	5.0	0.04	70.6	7.41	877
6/22/2004	3	31	1.33	2.83	0.08	0.0005	0.005	0.005	0.023	5.0	0.04	67.9	7.42	918
9/8/2004	3	92	1.51	1.82	0.31	0.0005	0.006	0.005	0.022	5.0	0.01	70.8	7.02	1600
9/28/2004	3	2	1.07	0.69	0.01	0.0005	0.002	0.005	0.020	5.0	0.03	64.5	7.11	812
11/4/2004	11	7	0.53	0.20	0.04	0.0005	0.003	0.005	0.020	5.0	0.01	48.9	7.01	1488
11/12/2004	6	6	0.71	0.20	0.03	0.0005	0.003	0.005	0.020	5.0	0.01	46.1	6.88	693
12/23/2004	2	54	1.07	1.10	0.06	0.0005	0.004	0.005	0.020	5.0	0.01	42.6	6.83	0

Stormflow EMCs (mg/L) were calculated from data using the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 6. 2004 Baseflow Event Mean Concentrations (EMCs)
Station 002

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1/29/2004	0	0	2.27	0.00	0.00	0.0000	0.000	0.000	0.040	0.0	0.02	32.4	7.00	0
2/26/2004	0	0	1.70	0.47	0.02	0.0000	0.000	0.000	0.000	0.0	0.05	34.4	7.57	5
3/24/2004	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	48.1	7.68	0
4/22/2004	0	0	0.51	0.00	0.07	0.0000	0.000	0.000	0.000	0.0	0.03	64.6	7.00	41
5/4/2004	1	0	0.12	0.63	0.03	0.0000	0.000	0.000	0.000	0.0	0.02	69.8	8.09	137
6/24/2004	0	5	0.00	2.80	0.04	0.0000	0.000	0.000	0.000	0.0	0.02	67.0	7.26	107
8/26/2004	0	8	0.05	0.00	0.03	0.0000	0.000	0.000	0.000	0.0	0.04	65.2	6.98	25
9/21/2004	0	2	0.00	0.00	0.06	0.0000	0.000	0.000	0.000	0.0	0.04	58.7	6.93	200
11/2/2004	0	0	0.07	0.00	0.01	0.0000	0.000	0.000	0.000	0.0	0.00	47.6	7.14	11
11/30/2004	1	0	1.20	0.00	0.01	0.0000	0.001	0.000	0.000	0.0	0.00	44.1	6.32	43

Baseflow EMCs (mg/L) were calculated from data using zero for concentrations less than the detection limit (DL).

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1/29/2004	1	1	2.27	0.10	0.01	0.0003	0.001	0.003	0.040	2.5	0.02	32.4	7.00	1
2/26/2004	1	1	1.70	0.53	0.02	0.0003	0.001	0.003	0.010	2.5	0.05	34.4	7.57	5
3/24/2004	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	48.1	7.68	1
4/22/2004	1	1	0.51	0.10	0.07	0.0003	0.001	0.003	0.010	2.5	0.03	64.6	7.00	41
5/4/2004	2	1	0.12	0.70	0.03	0.0003	0.001	0.003	0.010	2.5	0.02	69.8	8.09	137
6/24/2004	1	5	0.03	2.80	0.04	0.0003	0.001	0.003	0.010	2.5	0.02	67.0	7.26	107
8/26/2004	1	8	0.05	0.10	0.03	0.0003	0.001	0.003	0.010	2.5	0.04	65.2	6.98	25
9/21/2004	1	3	0.03	0.10	0.06	0.0003	0.001	0.003	0.010	2.5	0.04	58.7	6.93	200
11/2/2004	1	1	0.07	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.01	47.6	7.14	11
11/30/2004	2	1	1.20	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.01	44.1	6.32	43

Baseflow EMCs (mg/L) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 6 (continued). 2004 Baseflow Event Mean Concentrations (EMCs)
Station 002

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1/29/2004	2	3	2.27	0.20	0.01	0.0005	0.002	0.005	0.040	5.0	0.02	32.4	7.00	2
2/26/2004	2	3	1.70	0.60	0.02	0.0005	0.002	0.005	0.020	5.0	0.05	34.4	7.57	5
3/24/2004	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	48.1	7.68	2
4/22/2004	2	3	0.51	0.20	0.07	0.0005	0.002	0.005	0.020	5.0	0.03	64.6	7.00	41
5/4/2004	2	3	0.12	0.77	0.03	0.0005	0.002	0.005	0.020	5.0	0.02	69.8	8.09	137
6/24/2004	2	5	0.05	2.80	0.04	0.0005	0.002	0.005	0.020	5.0	0.02	67.0	7.26	107
8/26/2004	2	8	0.05	0.20	0.03	0.0005	0.002	0.005	0.020	5.0	0.04	65.2	6.98	25
9/21/2004	2	3	0.05	0.20	0.06	0.0005	0.002	0.005	0.020	5.0	0.04	58.7	6.93	200
11/2/2004	2	3	0.07	0.20	0.01	0.0005	0.002	0.005	0.020	5.0	0.01	47.6	7.14	11
11/30/2004	3	3	1.20	0.20	0.01	0.0005	0.002	0.005	0.020	5.0	0.01	44.1	6.32	43

Baseflow EMCs (mg/L) were calculated from data using the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 7. 2004 Stormflow Event Mean Concentrations (EMCs)
Station 002

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
3/16/2004	0	4	1.04	0.00	0.03	0.0000	0.003	0.000	0.010	0.0	0.02	37.5	7.96	26
6/4/2004	1	20	0.61	1.80	0.09	0.0000	0.001	0.000	0.006	0.0	0.01	62.2	7.55	-999
6/10/2004	2	80	0.14	1.13	0.28	0.0000	0.000	0.000	0.008	0.0	0.03	71.7	7.75	1180
6/22/2004	8	18	0.37	2.96	0.07	0.0000	0.001	0.000	0.011	0.0	0.05	72.2	6.62	1600
9/8/2004	38	233	0.44	3.24	0.62	0.0000	0.005	0.000	0.035	0.0	0.04	-999	6.72	1600
9/28/2004	15	35	0.31	0.90	0.22	0.0000	0.001	0.000	0.031	0.0	0.04	-999	6.88	1600
11/4/2004	4	5	0.23	0.36	0.05	0.0000	0.003	0.000	0.004	0.0	0.01	48.7	7.20	1129
11/12/2004	5	10	0.55	0.43	0.04	0.0000	0.003	0.000	0.007	0.0	0.01	44.9	6.52	1090
12/23/2004	0	52	0.63	1.36	0.05	0.0000	0.002	0.000	0.015	0.0	0.64	45.6	6.93	-999

Stormflow EMCs (mg/L) were calculated from data using zero for concentrations less than the detection limit (DL).

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
3/16/2004	1	4	1.04	0.10	0.03	0.0003	0.003	0.003	0.015	2.5	0.02	37.5	7.96	26
6/4/2004	2	20	0.63	1.80	0.09	0.0003	0.002	0.003	0.014	2.5	0.01	62.2	7.55	-999
6/10/2004	3	81	0.14	1.17	0.28	0.0003	0.001	0.003	0.015	2.5	0.03	71.7	7.75	1180
6/22/2004	8	18	0.38	2.96	0.07	0.0003	0.002	0.003	0.017	2.5	0.05	72.2	6.62	1600
9/8/2004	38	233	0.44	3.24	0.62	0.0003	0.005	0.003	0.038	2.5	0.04	-999	6.72	1600
9/28/2004	15	35	0.31	0.93	0.22	0.0003	0.002	0.003	0.031	2.5	0.04	-999	6.88	1600
11/4/2004	4	5	0.24	0.43	0.05	0.0003	0.003	0.003	0.012	2.5	0.01	48.7	7.20	1129
11/12/2004	5	10	0.55	0.50	0.04	0.0003	0.003	0.003	0.013	2.5	0.01	44.9	6.52	1090
12/23/2004	1	52	0.63	1.36	0.05	0.0003	0.002	0.003	0.020	2.5	0.64	45.6	6.93	-999

Stormflow EMCs (mg/L) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 7 (continued). 2004 Stormflow Event Mean Concentrations (EMCs)
Station 002

Date	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
3/16/2004	2	5	1.04	0.20	0.03	0.0005	0.003	0.005	0.020	5.0	0.02	37.5	7.96	26
6/4/2004	3	20	0.64	1.80	0.09	0.0005	0.003	0.005	0.023	5.0	0.01	62.2	7.55	-999
6/10/2004	4	81	0.14	1.21	0.28	0.0005	0.002	0.005	0.023	5.0	0.03	71.7	7.75	1180
6/22/2004	8	18	0.39	2.96	0.07	0.0005	0.003	0.005	0.024	5.0	0.05	72.2	6.62	1600
9/8/2004	39	233	0.44	3.24	0.62	0.0005	0.005	0.005	0.040	5.0	0.04	-999	6.72	1600
9/28/2004	15	35	0.31	0.96	0.23	0.0005	0.003	0.005	0.031	5.0	0.04	-999	6.88	1600
11/4/2004	5	6	0.24	0.50	0.05	0.0005	0.004	0.005	0.020	5.0	0.01	48.7	7.20	1129
11/12/2004	5	11	0.55	0.57	0.04	0.0005	0.003	0.005	0.020	5.0	0.01	44.9	6.52	1090
12/23/2004	2	52	0.63	1.36	0.05	0.0005	0.002	0.005	0.024	5.0	0.64	45.6	6.93	-999

Stormflow EMCs (mg/L) were calculated from data using the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 8. 2004 Monthly Event Mean Concentrations (EMCs)
Station 001

Month	Event Type	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1	BASEFLOW	0	0	2.27	0.00	0.00	0.0000	0.001	0.000	0.000	0.0	0.02	33.1	7.37	1
2	BASEFLOW	0	0	1.97	0.00	0.01	0.0000	0.000	0.000	0.000	0.0	0.03	143.7	7.18	18
3	BASEFLOW	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	47.4	7.64	15
3	STORM	1	16	1.52	0.00	0.05	0.0000	0.003	0.000	0.012	0.0	0.02	38.1	6.88	425
4	BASEFLOW	0	1	1.50	0.33	0.09	0.0000	0.000	0.000	0.007	0.0	0.01	58.8	7.65	177
5	BASEFLOW	1	5	1.40	0.00	0.02	0.0000	0.000	0.000	0.000	0.0	0.01	63.5	7.23	117
6	BASEFLOW	0	5	1.20	2.90	0.02	0.0000	0.003	0.000	0.000	0.0	0.02	65.2	7.41	393
6	STORM	3	31	1.33	2.49	0.09	0.0000	0.005	0.000	0.010	0.0	0.04	67.9	7.41	898
8	BASEFLOW	0	3	1.30	0.00	0.01	0.0000	0.000	0.000	0.000	0.0	0.03	66.8	7.57	80
9	BASEFLOW	0	1	1.13	0.00	0.03	0.0000	0.001	0.000	0.000	0.0	0.02	56.8	7.38	110
9	STORM	1	46	1.29	1.25	0.16	0.0000	0.004	0.000	0.007	0.0	0.02	67.7	7.07	1206
11	BASEFLOW	0	1	1.12	0.00	0.01	0.0000	0.000	0.000	0.000	0.0	0.00	49.7	7.11	104
11	STORM	9	6	0.62	0.00	0.04	0.0000	0.003	0.000	0.000	0.0	0.01	47.5	6.94	1090
12	STORM	0	54	1.07	1.03	0.05	0.0000	0.004	0.000	0.000	0.0	0.00	42.6	6.83	0

Monthly EMCs (mg/L) were calculated from data using zero for concentrations less than the detection limit DL.

Month	Event Type	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1	BASEFLOW	1	1	2.27	0.10	0.01	0.0003	0.002	0.003	0.010	2.5	0.02	33.1	7.37	1
2	BASEFLOW	1	1	1.97	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.03	143.7	7.18	18
3	BASEFLOW	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	47.4	7.64	15
3	STORM	1	16	1.52	0.10	0.05	0.0003	0.003	0.003	0.016	2.5	0.02	38.1	6.88	425
4	BASEFLOW	1	2	1.50	0.40	0.09	0.0003	0.001	0.003	0.013	2.5	0.01	58.8	7.65	177
5	BASEFLOW	1	5	1.40	0.10	0.02	0.0003	0.001	0.003	0.010	2.5	0.01	63.5	7.23	117
6	BASEFLOW	1	5	1.20	2.90	0.02	0.0003	0.003	0.003	0.010	2.5	0.02	65.2	7.41	393
6	STORM	3	31	1.33	2.49	0.09	0.0003	0.005	0.003	0.017	2.5	0.04	67.9	7.41	898
8	BASEFLOW	1	3	1.30	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.03	66.8	7.57	80
9	BASEFLOW	1	2	1.13	0.10	0.03	0.0003	0.001	0.003	0.010	2.5	0.02	56.8	7.38	110
9	STORM	2	47	1.29	1.25	0.16	0.0003	0.004	0.003	0.014	2.5	0.02	67.7	7.07	1206
11	BASEFLOW	1	2	1.12	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.01	49.7	7.11	104
11	STORM	9	6	0.62	0.10	0.04	0.0003	0.003	0.003	0.010	2.5	0.01	47.5	6.94	1090
12	STORM	1	54	1.07	1.07	0.06	0.0003	0.004	0.003	0.010	2.5	0.01	42.6	6.83	0

Monthly EMCs (mg/L) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 9. 2004 Monthly Event Mean Concentrations (EMCs)
Station 002

Month	Event Type	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1	BASEFLOW	0	0	2.27	0.00	0.00	0.0000	0.000	0.000	0.040	0.0	0.02	32.4	7.00	0
2	BASEFLOW	0	0	1.70	0.47	0.02	0.0000	0.000	0.000	0.000	0.0	0.05	34.4	7.57	5
3	BASEFLOW	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	48.1	7.68	0
3	STORM	0	4	1.04	0.00	0.03	0.0000	0.003	0.000	0.010	0.0	0.02	37.5	7.96	26
4	BASEFLOW	0	0	0.51	0.00	0.07	0.0000	0.000	0.000	0.000	0.0	0.03	64.6	7.00	41
5	BASEFLOW	1	0	0.12	0.63	0.03	0.0000	0.000	0.000	0.000	0.0	0.02	69.8	8.09	137
6	BASEFLOW	0	5	0.00	2.80	0.04	0.0000	0.000	0.000	0.000	0.0	0.02	67.0	7.26	107
6	STORM	2	20	0.37	1.80	0.09	0.0000	0.001	0.000	0.008	0.0	0.03	71.7	7.55	1390
8	BASEFLOW	0	8	0.05	0.00	0.03	0.0000	0.000	0.000	0.000	0.0	0.04	65.2	6.98	25
9	BASEFLOW	0	2	0.00	0.00	0.06	0.0000	0.000	0.000	0.000	0.0	0.04	58.7	6.93	200
9	STORM	27	134	0.38	2.07	0.42	0.0000	0.003	0.000	0.033	0.0	0.04	-999	6.80	1600
11	BASEFLOW	1	0	0.63	0.00	0.01	0.0000	0.000	0.000	0.000	0.0	0.00	45.8	6.73	27
11	STORM	4	8	0.39	0.40	0.04	0.0000	0.003	0.000	0.005	0.0	0.01	46.8	6.86	1109
12	STORM	0	52	0.63	1.36	0.05	0.0000	0.002	0.000	0.015	0.0	0.64	45.6	6.93	-999

Monthly EMCs (mg/L) were calculated from data using zero for concentrations less than the detection limit (DL).

Month	Event Type	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Temp*	pH**	Fecals***
1	BASEFLOW	1	1	2.27	0.10	0.01	0.0003	0.001	0.003	0.040	2.5	0.02	32.4	7.00	1
2	BASEFLOW	1	1	1.70	0.53	0.02	0.0003	0.001	0.003	0.010	2.5	0.05	34.4	7.57	5
3	BASEFLOW	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	-999	48.1	7.68	1
3	STORM	1	4	1.04	0.10	0.03	0.0003	0.003	0.003	0.015	2.5	0.02	37.5	7.96	26
4	BASEFLOW	1	1	0.51	0.10	0.07	0.0003	0.001	0.003	0.010	2.5	0.03	64.6	7.00	41
5	BASEFLOW	2	1	0.12	0.70	0.03	0.0003	0.001	0.003	0.010	2.5	0.02	69.8	8.09	137
6	BASEFLOW	1	5	0.03	2.80	0.04	0.0003	0.001	0.003	0.010	2.5	0.02	67.0	7.26	107
6	STORM	3	20	0.38	1.80	0.09	0.0003	0.002	0.003	0.015	2.5	0.03	71.7	7.55	1390
8	BASEFLOW	1	8	0.05	0.10	0.03	0.0003	0.001	0.003	0.010	2.5	0.04	65.2	6.98	25
9	BASEFLOW	1	3	0.03	0.10	0.06	0.0003	0.001	0.003	0.010	2.5	0.04	58.7	6.93	200
9	STORM	27	134	0.38	2.08	0.42	0.0003	0.003	0.003	0.034	2.5	0.04	-999	6.80	1600
11	BASEFLOW	1	1	0.63	0.10	0.01	0.0003	0.001	0.003	0.010	2.5	0.01	45.8	6.73	27
11	STORM	5	8	0.39	0.47	0.04	0.0003	0.003	0.003	0.013	2.5	0.01	46.8	6.86	1109
12	STORM	1	52	0.63	1.36	0.05	0.0003	0.002	0.003	0.020	2.5	0.64	45.6	6.93	-999

Monthly EMCs (mg/L) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* deg F
** no units
*** MPN/100mL

Table 10
Maryland Freshwater Water Quality Criteria
for Ambient Surface Waters (mg/L)

Parameter Name	Acute Criteria	Chronic Criteria
Total Cadmium	0.0043	0.0022
Total Copper	0.013	0.009
Total Lead	0.065	0.0025
Total Zinc	0.12	0.12

Code of Maryland Regulations, 26.08.02, Water Quality. Maryland Department of the Environment, Baltimore, Maryland.

Comparison of EMCs with Maryland National Pollutant Discharge Elimination System (NPDES) and Nationwide Urban Runoff Program (NURP)

Average yearly EMCs for stations 001 and 002 were compared to NPDES from Maryland and NURP (EPA, 1983). This information was derived from the Maryland's NPDES Municipal Stormwater Monitoring, Maryland Department of the Environment, Water Management Administration, 1997 (Table 7, pg. 16). The 2004 data is presented in Table 11 and the comprehensive data from 1998-2003 is located in Appendix A. The average yearly EMCs are significantly lower than the Maryland NPDES EMCs and NURP EMCs with the exception of nitrate plus nitrite.

Table 11
Comparison of 2004 Event Mean Concentrations (EMCs)
with Maryland NPDES EMCs and NURP Residential EMCs

Parameter	Average Yearly EMC (mg/L)	Maryland NPDES (mg/L)	NURP Residential EMCs (mg/L)
Upstream Station (Outfall)			
Biological Oxygen Demand	4.03	14.26	11
Total Suspended Solids	19.88	55.08	140
Nitrate plus Nitrite	0.44	0.97	0.96
Total Kjeldahl Nitrogen	1.13	1.75	2.35
Total Phosphorus	0.07	0.37	0.47
Total Phenols	**0.034**	**0.0022**	--
Total Cadmium	0.00	0.00004	--
Total Copper	0.002	0.0141	0.05
Total Lead	0.00	0.0057	0.18
Total Zinc	0.010	0.0893	0.18
Fecal Coliform (MPN/mL)	1179.53	2309.12	--
Downstream Station (Instream)			
Biological Oxygen Demand	1.54	14.26	11
Total Suspended Solids	16.04	55.08	140
Nitrate plus Nitrite	**1.07**	**0.97**	**0.96**
Total Kjeldahl Nitrogen	1.03	1.75	2.35
Total Phosphorus	0.05	0.37	0.47
Total Phenols	**0.018**	**0.0022**	--
Total Cadmium	0.00	0.00004	--
Total Copper	0.003	0.0141	0.05
Total Lead	0.00	0.0057	0.18
Total Zinc	0.00	0.0893	0.18

Note: Bold and shaded values represent exceedences.

Correlation between Stations and Benthic Data using Pearson Product Moment Correlation

A correlation matrix was computed using the Pearson Product Moment correlation coefficients for all constituent pairs and the benthic data.

The benthic macroinvertebrates observed at three stations from the County's ambient monitoring program (Figure 12) were compared using the metrics and data analysis following the Maryland Biological Stream Survey (MBSS) program guidance documents. Metrics were used to calculate the Index of Biotic Integrity (IBI) for the Piedmont or Non-Coastal Plain per the MBSS guidance (Stribling et al 1998). Based on scoring criteria established by MBSS, the IBI values were calculated and scores assigned to each sampling station.

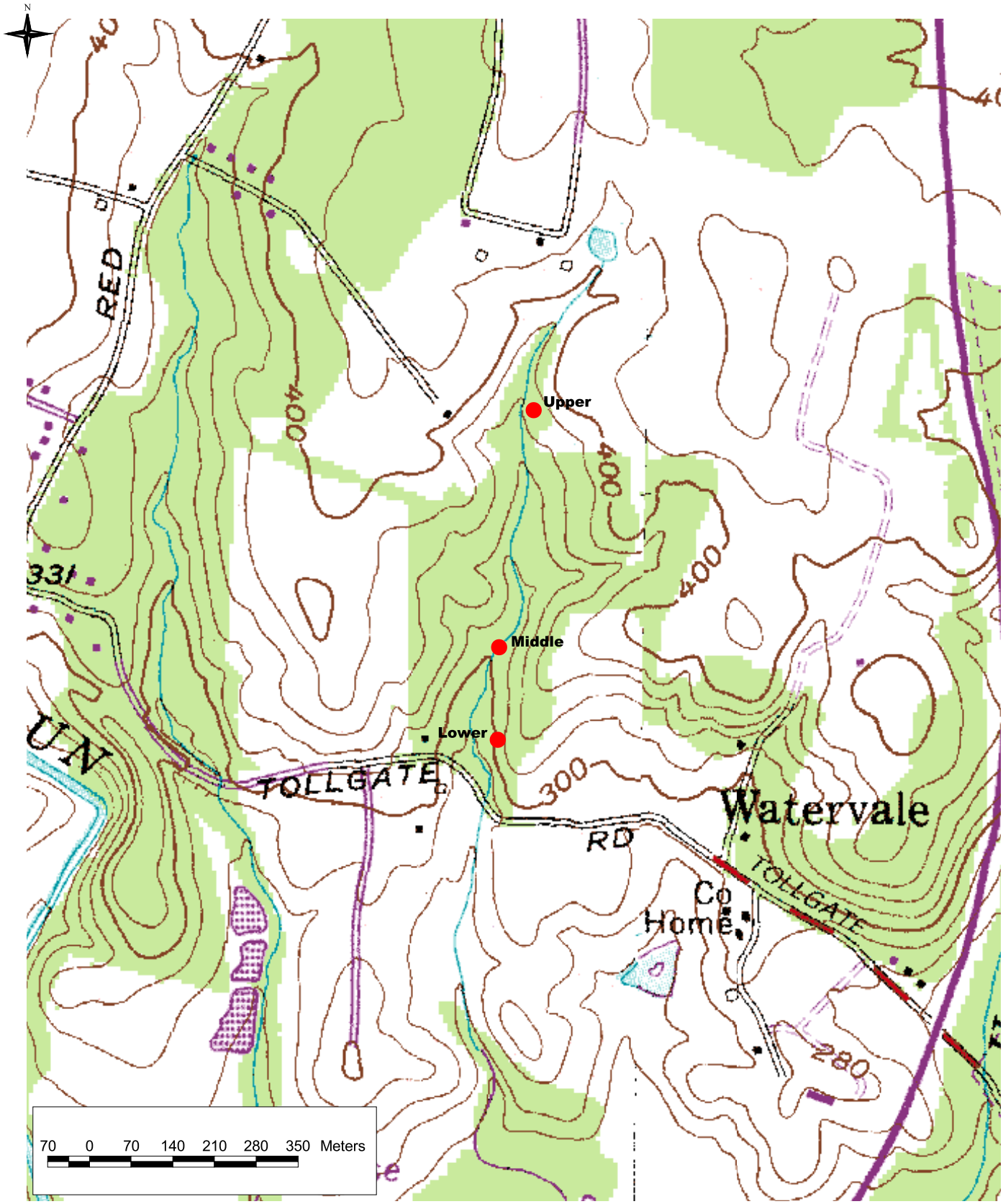
			HBI		IBI		%URI	
Year	**Season**	**Station**	**Score**	**Class**	**Score**	**Class**	**Score**	**Class**
2004	SPRING	001	2.94	Good	2.48	Poor	96.93	Approaching Attainable
2004	SPRING	002	2.75	Good	2.26	Poor	88.25	Approaching Attainable
2004	FALL	001	2.56	Good	2.04	Poor	79.57	Approaching Attainable
2004	FALL	002	2.43	Good	1.44	Very Poor	56.42	Improvement Needed

In addition to the selected metrics used in the IBI, the Hilsenhoff Biotic Index (HBI) was also calculated as an indicator of the biological condition of the streams surveyed. The HBI is most useful for discerning degradation due to organic pollutants. The HBI values were calculated and rated according to the categories adopted by MBSS.

HBI scores rated the downstream and upstream station as good during the spring and fall season. The low scores during this study period and the lack of taxa tolerant at high organic levels indicate that organic pollution does not appear to be an issue according to the HBI scores.

IBI scores on average rated the downstream and upstream station as very poor or poor during the spring and fall season. Results of statistically analysis (Wilcoxon Rank-Sum) indicated that the IBI scores in the upstream station were significantly lower than the scores in downstream station.

The IBI data was compared to the urban reference condition in Maryland using the urban reference index (URI). During the fall sampling period, most stations were rated as approaching attainable community in the urban environment. In the spring, most stations were rated, as improvement needed.



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Hartford County
Benthic Monitoring

Harford County, Maryland

Figure 12.
Location of Sampling Stations

17 December 2003

The results of the Pearson product moment correlation are presented in Table 12.

Comparisons and Trend Analysis

A variance component model was used to conduct spatial and temporal trend analysis of EMCs. The variance component model included fixed effect terms for the two sampling stations 001 and 002, seasonal cyclicality, and temporal trend. The model also included random effect terms attributed to sample year and residual sampling error. The variance component model is given by the following:

$$\mathrm{EMC} = \mathrm{B}_0 + \mathrm{B}_{\mathrm{YEAR}} \times \mathrm{YEAR} + \mathrm{B}_{\mathrm{SEASON}} + \mathrm{B}_{\mathrm{SITE}} + \mathrm{N}_{(0,\sigma_{\mathrm{YEAR}})} + \mathrm{N}_{(0,\sigma_{\mathrm{RESIDUAL}})}$$

where

$\mathrm{EMC} =$ event mean concentration

$\mathrm{YEAR} =$ calendar year of EMC

$\mathrm{B}_0 =$ model intercept

$\mathrm{B}_{\mathrm{YEAR}} =$ temporal trend

$$\mathrm{B}_{\mathrm{SEASON}} = \text{season effect} \begin{cases} \mathrm{B}_{\mathrm{WINTER}} & \text{if season} = \text{winter} \\ \mathrm{B}_{\mathrm{SPRING}} & \text{if season} = \text{spring} \\ \mathrm{B}_{\mathrm{SUMMER}} & \text{if season} = \text{summer} \\ \mathrm{B}_{\mathrm{FALL}} & \text{if season} = \text{fall} \end{cases}$$

$$\mathrm{B}_{\mathrm{SEASON}} = \text{season effect} \begin{cases} \mathrm{B}_{001} & \text{if site} = 001 \\ \mathrm{B}_{002} & \text{if site} = 002 \end{cases}$$

$\mathrm{N}_{(0,\sigma_{\mathrm{year}})} =$ random year effect, distributed normally with mean of 0 and variance of σ^2_{year}

$\mathrm{N}_{(0,\sigma_{\mathrm{residual}})} =$ residual error, distributed normally with mean of 0 and variance of $\sigma^2_{\mathrm{residual}}$

Once the model coefficients have been determined, the trend line was computed by zeroing the random effect components $\mathrm{N}_{(0,\sigma_{\mathrm{year}})}$ and $\mathrm{N}_{(0,\sigma_{\mathrm{residual}})}$.

The results of the trend analysis are presented in Appendix B. A declining trend is observed in the biological oxygen demand, total suspended solids, total kjeldahl nitrogen, total phosphorus, total copper and, total zinc EMCs. There is no apparent trend in the nitrate and total nitrogen EMCs. There was strong seasonality in fecal coliform with concentrations during the summer months about 10 times higher than the rest of the year.

Table 12
Pearson Correlation Coefficients of EMCs to Benthic Metrics

Parameter	Station	Variable	HBI	IBI	URI
BOD5	001	EMC_ND0	0.10	-0.08	-0.08
BOD5	001	EMC_NDHalfDL	0.12	-0.06	-0.06
BOD5	002	EMC_ND0	0.21	0.02	0.02
BOD5	002	EMC_NDHalfDL	0.22	0.07	0.07
Cd	001	EMC_ND0	-0.05	-0.17	-0.17
Cd	001	EMC_NDHalfDL	-0.05	-0.17	-0.17
Cd	002	EMC_ND0	-0.31	-0.23	-0.23
Cd	002	EMC_NDHalfDL	-0.31	-0.23	-0.23
Cu	001	EMC_ND0	-0.30	0.45	0.45
Cu	001	EMC_NDHalfDL	-0.25	0.43	0.43
Cu	002	EMC_ND0	0.54	0.04	0.04
Cu	002	EMC_NDHalfDL	0.54	0.06	0.06
Fecals	001	EMC_ND0	-0.15	-0.45	-0.45
Fecals	001	EMC_NDHalfDL	-0.15	-0.45	-0.45
Fecals	002	EMC_ND0	0.33	-0.11	-0.11
Fecals	002	EMC_NDHalfDL	0.33	-0.11	-0.11
NO23	001	EMC_ND0	-0.25	0.45	0.45
NO23	001	EMC_NDHalfDL	-0.23	0.44	0.44
NO23	002	EMC_ND0	-0.19	-0.47	-0.47
NO23	002	EMC_NDHalfDL	-0.18	-0.47	-0.47
Pb	001	EMC_ND0	0.20	0.31	0.31
Pb	001	EMC_NDHalfDL	-0.07	0.25	0.25
Pb	002	EMC_ND0	0.44	0.15	0.15
Pb	002	EMC_NDHalfDL	-0.10	0.22	0.22
Phenols	001	EMC_ND0	0.15	-0.22	-0.22
Phenols	001	EMC_NDHalfDL	0.23	**-0.55**	**-0.55**
Phenols	002	EMC_ND0	-0.29	0.01	0.01
Phenols	002	EMC_NDHalfDL	-0.32	-0.16	-0.16
Temp	001	EMC_ND0	-0.05	0.47	0.47
Temp	001	EMC_NDHalfDL	-0.05	0.47	0.47
Temp	002	EMC_ND0	0.15	**0.67**	**0.67**
Temp	002	EMC_NDHalfDL	0.15	**0.67**	**0.67**
TKN	001	EMC_ND0	0.02	-0.10	-0.10
TKN	001	EMC_NDHalfDL	0.14	-0.17	-0.17
TKN	002	EMC_ND0	0.04	0.44	0.44
TKN	002	EMC_NDHalfDL	0.15	0.31	0.31
TN	001	EMC_ND0	-0.23	0.38	0.38
TN	001	EMC_NDHalfDL	-0.17	0.36	0.36
TN	002	EMC_ND0	-0.18	-0.20	-0.20
TN	002	EMC_NDHalfDL	-0.10	-0.32	-0.32
TP	001	EMC_ND0	-0.38	**0.64**	**0.64**
TP	001	EMC_NDHalfDL	-0.36	**0.63**	**0.63**
TP	002	EMC_ND0	0.21	0.40	0.40
TP	002	EMC_NDHalfDL	0.22	0.38	0.38
TPH	001	EMC_ND0	-0.11	0.24	0.24
TPH	001	EMC_NDHalfDL	-0.17	0.13	0.13
TPH	002	EMC_ND0	0.40	0.37	0.37
TPH	002	EMC_NDHalfDL	0.45	0.37	0.37
TSS	001	EMC_ND0	-0.05	**0.61**	**0.61**
TSS	001	EMC_NDHalfDL	-0.05	**0.61**	**0.61**
TSS	002	EMC_ND0	0.49	0.20	0.20
TSS	002	EMC_NDHalfDL	0.49	0.20	0.20
Zn	001	EMC_ND0	-0.39	0.36	0.36
Zn	001	EMC_NDHalfDL	**-0.59**	0.40	0.40
Zn	002	EMC_ND0	0.20	-0.06	-0.06
Zn	002	EMC_NDHalfDL	0.13	0.00	0.00

Note: Bolded values are significant at the 95% significance level.

HBI = Hilsenhoff Biotic Index
IBI = Index of Biotic Integrity
URI = %Urban Rference Index

Pollutant Loads

The method used to determine the pollutant loading for each station is based on the Simple Method (Schueler, 1987). The Simple Method is given by the following equation:

$$L_i = 1/12*P*CF*Rv_i*C_i*A_i*2.72$$

Where:
L_i = Annual pollutant load (lbs/outfall/yr)
P = Annual precipitation (in/yr)
Pj = Proportion storms where runoff occurs
Rv_i = Weighted Runoff coefficient for the area served by the outfall
C_i = Event Mean Concentration of pollutant (mg/L)
A_i = Catchment area (acres)
1/12 = Conversion factor
2.72 = Conversion factor

The parameter Pj was determined by calculating the proportion of storms that produced runoff for the period between 1998 through 2004. The value of Pj was found to be 0.95.

The continuous streamflow and water-quality data from the upstream location were used to estimate the loads. Annual and seasonal pollutant loads were calculated based on based on data using zero for concentrations less than the detection limit (DL) (nd=0), and half of the DL for concentrations less than the DL (nd=1/2DL). Loading rates and yields were also determined. The data is presented in Tables 13 through 16.

Comparison with available NPS Data

The annual loading yields (lbs/acre/yr) for total kjeldahl nitrogen (TKN); nitrate plus nitrite (NO_2NO_3) and total phosphorus were compared to nitrogen and phosphorus loading rates (lbs/acre) for selected watersheds in Maryland (Aberdeen Proving Ground, Bynum Run and Lower Winters Run). The information was downloaded from the website: http://www.dnr.state.md.us/bay/czm/nps/. The yields compared were calculated using one half of the detection limit (DL) for concentrations less than the DL. The information is presented in Figures 13 and 14. The Watershed profiles for Aberdeen Proving Ground, Bynum Run and Lower Winters Run are in Appendix C.

Table 13. 1998-2004 Annual Loads and Yields
Station 002

Year	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals*
1998	1920	15079	0.00	436.87	58.12	0.0000	3.371	0.502	15.582	0.0	0.00	
1999	618	5689	335.34	101.09	23.95	0.0000	2.273	0.000	9.497	0.0	0.00	2,154,175
2000	520	2883	185.24	81.58	24.79	0.0000	0.676	0.000	3.772	0.0	0.00	33,441
2001	373	5724	103.46	118.31	22.21	0.0000	0.963	0.000	4.174	535.7	5.36	589,330
2002	29	1930	106.19	79.82	21.90	0.0000	0.945	0.000	4.691	632.4	6.32	868,993
2003	2642	8388	1126.74	200.02	42.42	0.0000	3.312	0.000	9.549	0.0	0.00	3,311,461
2004	3822	18856	518.83	1075.22	87.51	0.0000	1.973	0.000	9.663	0.0	49.15	5,195,201

Annual loads (lbs/yr) were calculated from data using zero for concentrations less than the detection limit DL.

Year	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals**
1998	24	191	0.00	5.53	0.74	0.0000	0.043	0.006	0.197	0.0	0.00	
1999	8	72	4.24	1.28	0.30	0.0000	0.029	0.000	0.120	0.0	0.00	27,261
2000	7	36	2.34	1.03	0.31	0.0000	0.009	0.000	0.048	0.0	0.00	423
2001	5	72	1.31	1.50	0.28	0.0000	0.012	0.000	0.053	6.8	0.07	7,458
2002	0	24	1.34	1.01	0.28	0.0000	0.012	0.000	0.059	8.0	0.08	10,997
2003	33	106	14.26	2.53	0.54	0.0000	0.042	0.000	0.121	0.0	0.00	41,907
2004	48	239	6.57	13.61	1.11	0.0000	0.025	0.000	0.122	0.0	0.62	65,745

Yields (lbs/acre/yr) were calculated from data using zero for concentrations less than the detection limit DL.

Year	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals*
1998	1985	15111	10.03	469.43	58.55	0.0627	3.436	0.640	15.582	626.7	6.27	
1999	818	5689	335.34	245.36	24.10	0.0951	2.361	0.380	9.497	951.1	9.51	2,154,175
2000	659	3016	185.24	138.50	24.79	0.0609	0.815	0.244	3.772	609.2	6.09	33,441
2001	463	5848	104.81	145.86	22.21	0.0536	1.046	0.214	4.174	535.7	5.36	589,330
2002	279	2118	108.01	122.07	21.97	0.0632	1.056	0.253	4.691	632.4	6.32	868,993
2003	2878	9246	1127.65	247.53	42.42	0.2387	3.628	0.955	9.549	2387.3	23.87	3,311,461
2004	4940	19893	518.83	1192.61	87.51	0.4445	2.998	4.445	22.613	4445.1	49.15	5,195,201

Annual loads (lbs/yr) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

Year	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals**
1998	25	191	0.13	5.94	0.74	0.0008	0.043	0.008	0.197	7.9	0.08	
1999	10	72	4.24	3.11	0.30	0.0012	0.030	0.005	0.120	12.0	0.12	27,261
2000	8	38	2.34	1.75	0.31	0.0008	0.010	0.003	0.048	7.7	0.08	423
2001	6	74	1.33	1.85	0.28	0.0007	0.013	0.003	0.053	6.8	0.07	7,458
2002	4	27	1.37	1.54	0.28	0.0008	0.013	0.003	0.059	8.0	0.08	10,997
2003	36	117	14.27	3.13	0.54	0.0030	0.046	0.012	0.121	30.2	0.30	41,907
2004	63	252	6.57	15.09	1.11	0.0056	0.038	0.056	0.286	56.3	0.62	65,745

Yields (lbs/acre/yr) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* million MPN/yr
** million MPN/acre/yr

Table 14. 1998-2004 Annual Loads and Yields
Station 001

Year	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals*
1998	6709	118123	0.00	527.27	132.93	0.0000	2.521	0.139	7.256	0.0	0.00	
1999	1548	11213	780.00	0.00	48.52	0.0000	5.750	0.000	6.812	0.0	0.00	3,969,030
2000	409	6528	541.94	173.52	40.58	0.0000	2.688	0.000	6.481	0.0	0.00	36,155
2001	804	8356	553.34	112.53	38.31	0.0000	2.338	0.053	4.025	1146.2	11.46	1,572,159
2002	0	10487	524.71	81.46	42.48	0.0000	2.374	0.000	4.908	1298.0	12.98	1,370,415
2003	3620	28463	3196.69	331.74	77.32	0.0000	9.368	0.165	15.055	0.0	0.00	7,037,053
2004	1516	16851	2339.23	1016.78	64.70	0.0000	3.184	0.000	0.000	0.0	33.44	4,161,967

Annual loads (lbs/yr) were calculated from data using zero for concentrations less than the detection limit DL.

Year	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals**
1998	40	699	0.00	3.12	0.79	0.0000	0.015	0.001	0.043	0.0	0.00	0
1999	9	66	4.61	0.00	0.29	0.0000	0.034	0.000	0.040	0.0	0.00	23,473
2000	2	39	3.21	1.03	0.24	0.0000	0.016	0.000	0.038	0.0	0.00	214
2001	5	49	3.27	0.67	0.23	0.0000	0.014	0.000	0.024	6.8	0.07	9,298
2002	0	62	3.10	0.48	0.25	0.0000	0.014	0.000	0.029	7.7	0.08	8,105
2003	21	168	18.91	1.96	0.46	0.0000	0.055	0.001	0.089	0.0	0.00	41,617
2004	9	100	13.83	6.01	0.38	0.0000	0.019	0.000	0.000	0.0	0.20	24,614

Yields (lbs/acre/yr) were calculated from data using zero for concentrations less than the detection limit DL.

Year	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals*
1998	6779	118158	20.66	596.96	133.63	0.1291	2.637	0.586	7.291	1291.4	12.91	
1999	1976	11257	780.00	407.04	49.14	0.2035	5.946	0.814	6.908	2035.2	20.35	4,229,459
2000	737	6810	541.94	267.46	40.58	0.1293	2.947	0.517	6.665	1293.3	12.93	36,155
2001	995	8534	553.34	229.25	38.31	0.1146	2.453	0.485	4.217	1146.2	11.46	1,572,159
2002	519	10828	524.71	237.17	42.48	0.1298	2.535	0.519	5.084	1298.0	12.98	1,370,415
2003	4637	29988	3196.69	466.85	82.41	0.5095	10.026	2.148	15.055	5095.1	50.95	7,037,053
2004	3013	17462	2339.23	1127.96	66.34	0.4751	4.141	4.751	19.005	4751.2	33.44	4,161,967

Annual loads (lbs/yr) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

Year	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals**
1998	40	699	0.12	3.53	0.79	0.0008	0.016	0.003	0.043	7.6	0.08	0
1999	12	67	4.61	2.41	0.29	0.0012	0.035	0.005	0.041	12.0	0.12	25,013
2000	4	40	3.21	1.58	0.24	0.0008	0.017	0.003	0.039	7.6	0.08	214
2001	6	50	3.27	1.36	0.23	0.0007	0.015	0.003	0.025	6.8	0.07	9,298
2002	3	64	3.10	1.40	0.25	0.0008	0.015	0.003	0.030	7.7	0.08	8,105
2003	27	177	18.91	2.76	0.49	0.0030	0.059	0.013	0.089	30.1	0.30	41,617
2004	18	103	13.83	6.67	0.39	0.0028	0.024	0.028	0.112	28.1	0.20	24,614

Yields (lbs/acre/yr) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* million MPN/yr
** million MPN/acre/yr

Table 15. 1998-2004 Seasonal Loads
Station 002

Year	Season	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals*
1998	SUMMER	202	1725	0.00	67.67	18.62	0.0000	0.581	0.035	2.690	0.4	0.00	
1998	FALL	218	1007	0.00	15.39	3.06	0.0000	0.100	0.030	0.886	0.0	0.00	
1999	WINTER	0	5175	65.42	0.00	4.55	0.0000	0.377	0.000	2.493	0.0	0.00	
1999	SPRING	47	2815	10.72	33.51	4.04	0.0000	0.254	0.073	1.619	0.0	0.00	
1999	SUMMER	325	1549	85.80	36.86	10.39	0.0000	0.398	0.000	3.478	0.0	0.00	1,071,481
1999	FALL	119	1023	54.52	52.80	4.51	0.0000	0.497	0.000	1.535	60.7	0.77	381,916
2000	WINTER	161	836	50.80	53.83	3.95	0.0000	0.271	0.000	0.806	0.0	0.00	
2000	SPRING	96	673	23.46	21.01	5.70	0.0000	0.182	0.000	0.769	0.0	0.86	
2000	SUMMER	31	259	9.49	12.46	4.60	0.0000	0.096	0.000	0.559	0.0	0.00	
2000	FALL	326	626	37.51	25.20	5.01	0.0000	0.277	0.006	0.839	0.0	0.00	
2001	WINTER	174	1361	44.81	57.69	7.14	0.0000	0.491	0.000	2.311	153.5	1.54	
2001	SPRING	120	2165	0.00	36.65	4.82	0.0000	0.311	0.035	1.231	1002.6	1.00	
2001	SUMMER	162	1315	20.92	18.57	3.84	0.0000	0.154	0.000	0.878	59.0	0.59	
2001	FALL	21	51	3.57	2.18	0.69	0.0000	0.013	0.000	0.124	45.5	0.17	28,914
2002	WINTER	0	217	7.83	5.59	1.48	0.0000	0.109	0.011	0.362	37.2	0.37	43,841
2002	SPRING	32	293	8.72	22.06	3.12	0.0000	0.191	0.000	0.883	68.5	0.69	151,740
2002	SUMMER	0	147	4.46	7.83	1.65	0.0000	0.032	0.000	0.323	41.7	0.34	112,548
2002	FALL	79	2752	58.08	73.33	7.57	0.0014	0.541	0.018	4.391	207.0	2.07	600,483
2003	WINTER	636	8401	247.42	91.50	18.24	0.0037	2.163	0.115	10.820	0.0	0.00	883,549
2003	SPRING	269	1125	0.00	47.13	5.11	0.0000	0.686	0.000	1.166	0.0	0.00	526,314
2003	SUMMER	333	2263	105.67	34.48	4.27	0.0000	0.514	0.000	0.915	0.0	0.00	635,328
2003	FALL	192	763	203.40	36.14	5.53	0.0000	0.487	0.000	1.040	0.0	0.87	630,198
2004	WINTER	83	825	623.73	49.56	7.95	0.0000	0.534	0.000	6.240	0.0	10.81	23,012
2004	SPRING	671	5454	130.19	639.53	35.89	0.0000	0.309	0.000	2.096	0.0	13.98	1,838,345
2004	SUMMER	7028	36314	104.18	545.82	117.89	0.0000	0.772	0.000	8.740	0.0	16.67	1,999,342
2004	FALL	1005	2111	257.89	93.02	12.13	0.0000	0.610	0.000	1.431	0.0	2.51	1,106,920

Seasonal loads (lbs/season) were calculated from data using zero for concentrations less than the detection limit DL.

Year	Season	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals*
1998	SUMMER	202	1725	1.04	67.67	18.62	0.0065	0.581	0.056	2.690	64.8	0.65	
1998	FALL	218	1007	0.44	17.10	3.06	0.0027	0.105	0.034	0.886	27.3	0.27	
1999	WINTER	67	5175	65.42	33.46	4.79	0.0167	0.377	0.067	2.493	167.3	1.67	
1999	SPRING	60	2815	10.72	33.51	4.04	0.0056	0.254	0.077	1.619	55.8	0.56	
1999	SUMMER	377	1570	85.80	93.46	10.39	0.0369	0.431	0.148	3.478	369.3	3.69	1,071,481
1999	FALL	119	1023	54.52	60.62	4.51	0.0138	0.497	0.055	1.535	170.8	1.77	381,916
2000	WINTER	96	498	30.29	34.62	2.35	0.0063	0.162	0.025	0.481	63.3	0.63	
2000	SPRING	110	681	23.46	21.01	5.70	0.0102	0.202	0.041	0.769	102.1	1.70	
2000	SUMMER	54	296	10.04	19.38	4.60	0.0097	0.123	0.039	0.559	96.9	0.97	
2000	FALL	326	626	37.51	25.31	5.01	0.0085	0.277	0.037	0.839	84.6	0.85	
2001	WINTER	177	1361	44.81	57.69	7.14	0.0154	0.491	0.061	2.311	153.5	1.54	
2001	SPRING	140	2165	1.60	36.65	4.82	0.0100	0.311	0.060	1.231	1002.6	1.00	
2001	SUMMER	168	1315	21.11	18.57	3.84	0.0059	0.158	0.024	0.878	59.0	0.59	
2001	FALL	24	51	3.57	2.97	0.69	0.0017	0.015	0.007	0.124	45.5	0.17	28,914
2002	WINTER	15	219	7.86	5.71	1.48	0.0037	0.109	0.021	0.362	37.2	0.37	43,841
2002	SPRING	51	311	8.72	22.06	3.12	0.0069	0.191	0.027	0.883	68.5	0.69	151,740
2002	SUMMER	17	152	4.83	7.83	1.65	0.0042	0.041	0.017	0.323	41.7	0.34	112,548
2002	FALL	122	2752	58.08	73.33	7.57	0.0219	0.541	0.095	4.391	207.0	2.07	600,483
2003	WINTER	1028	11646	342.99	126.84	25.28	0.0764	2.998	0.437	14.999	733.7	7.34	1,224,841
2003	SPRING	269	1168	2.90	47.13	5.11	0.0181	0.686	0.073	1.166	181.4	1.81	526,314
2003	SUMMER	334	2341	106.02	34.48	4.27	0.0229	0.514	0.092	0.915	228.8	2.29	635,328
2003	FALL	241	774	203.40	38.37	5.53	0.0260	0.497	0.104	1.040	259.9	3.27	630,198
2004	WINTER	456	1133	623.73	86.81	8.66	0.1020	0.746	1.020	8.262	1019.8	10.98	23,975
2004	SPRING	1104	5739	131.63	654.76	35.89	0.1257	0.737	1.257	6.425	1256.8	13.98	1,838,345
2004	SUMMER	7229	36349	106.28	566.55	118.09	0.1080	1.090	1.080	10.747	1079.9	16.67	1,999,342
2004	FALL	1254	2476	257.89	129.41	12.31	0.1089	0.866	1.089	5.070	1088.6	3.43	1,106,920

Seasonal loads (lbs/season) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* million MPN/season

Table 16. 1998-2004 Seasonal Loads
Station 001

Year	Season	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals*
1998	SUMMER	725	23058	0.00	101.03	25.29	0.0000	0.733	0.205	2.775	31.7	0.00	
1998	FALL	490	713	0.00	30.89	2.21	0.0000	0.127	0.009	0.240	0.0	0.00	
1999	WINTER	0	1474	182.53	0.00	0.00	0.0000	0.617	0.000	0.988	0.0	0.00	
1999	SPRING	707	20944	29.12	106.06	12.14	0.0000	0.832	0.373	4.189	0.0	0.00	
1999	SUMMER	711	6472	288.73	119.87	19.49	0.0000	2.052	0.046	2.399	0.0	0.00	1,322,025
1999	FALL	237	1987	91.21	0.00	8.26	0.0000	1.089	0.000	1.367	630.2	0.00	756,659
2000	WINTER	334	2664	107.30	75.92	6.64	0.0000	0.760	0.142	1.980	0.0	0.00	
2000	SPRING	363	1236	132.93	36.54	6.53	0.0000	0.451	0.000	0.802	336.0	0.00	
2000	SUMMER	59	1473	75.36	16.74	11.06	0.0000	0.677	0.000	1.548	0.0	0.00	
2000	FALL	790	2780	48.17	58.53	16.49	0.0000	0.707	0.000	1.853	0.0	0.00	
2001	WINTER	375	3763	110.54	95.78	10.28	0.0000	1.005	0.025	2.736	328.5	3.29	
2001	SPRING	272	12057	429.95	52.34	9.66	0.0000	1.257	0.232	2.591	1665.9	2.13	
2001	SUMMER	245	3611	92.88	16.92	4.57	0.0002	0.486	0.060	0.472	126.2	1.26	
2001	FALL	19	79	13.02	1.48	1.40	0.0000	0.029	0.000	0.123	102.0	0.36	78,383
2002	WINTER	0	2176	23.14	6.20	2.89	0.0000	0.237	0.019	0.820	79.6	0.80	133,191
2002	SPRING	207	391	78.64	10.89	5.53	0.0000	0.117	0.000	0.249	146.7	1.47	49,578
2002	SUMMER	0	785	32.54	14.73	3.83	0.0047	0.204	0.000	0.338	89.3	0.73	259,049
2002	FALL	243	14196	114.33	89.12	13.02	0.0009	1.561	0.151	5.513	415.3	4.15	353,643
2003	WINTER	501	29430	656.82	132.88	27.53	0.0000	4.521	0.073	8.277	0.0	0.00	1,903,078
2003	SPRING	588	12050	6.62	82.72	10.48	0.0000	1.553	0.186	4.540	0.0	0.00	1,126,226
2003	SUMMER	905	3351	259.61	68.13	6.47	0.0000	1.506	0.260	1.958	0.0	0.00	1,359,211
2003	FALL	793	3783	476.06	32.76	13.35	0.0000	1.086	0.000	1.914	0.0	0.00	989,502
2004	WINTER	133	3427	871.75	0.00	11.67	0.0000	0.719	0.000	2.544	0.0	9.98	428,846
2004	SPRING	882	9725	687.94	762.92	30.35	0.0000	1.354	0.000	2.788	0.0	11.98	1,305,019
2004	SUMMER	329	12572	547.96	331.65	45.95	0.0000	1.009	0.000	1.775	0.0	8.81	1,519,492
2004	FALL	1431	1453	454.29	0.00	13.09	0.0000	0.835	0.000	0.000	0.0	2.30	844,942

Seasonal loads (lbs/season) were calculated from data using zero for concentrations less than the detection limit DL.

Year	Season	BOD5	TSS	NO23	TKN	TP	Cd	Cu	Pb	Zn	TPH	Phenols	Fecals*
1998	SUMMER	725	23058	2.23	101.03	25.29	0.0140	0.733	0.233	2.775	165.6	1.40	
1998	FALL	490	713	0.94	30.89	2.21	0.0058	0.127	0.028	0.251	58.5	0.58	
1999	WINTER	143	1474	182.53	71.59	1.43	0.0358	0.617	0.143	0.988	358.0	3.58	
1999	SPRING	707	20944	29.12	106.06	12.14	0.0120	0.832	0.373	4.189	119.5	1.20	
1999	SUMMER	830	6472	288.73	218.00	19.49	0.0790	2.103	0.339	2.565	790.3	7.90	2,292,795
1999	FALL	237	1987	91.21	59.14	8.26	0.0296	1.089	0.118	1.367	794.6	2.96	756,659
2000	WINTER	208	1664	67.01	56.25	4.15	0.0135	0.474	0.113	1.237	135.4	1.35	
2000	SPRING	391	1236	132.93	36.54	6.53	0.0219	0.451	0.087	0.824	526.5	2.19	
2000	SUMMER	112	1473	75.36	34.52	11.06	0.0207	0.695	0.083	1.548	207.3	2.07	
2000	FALL	790	2780	48.17	58.53	16.49	0.0181	0.707	0.072	1.853	181.0	1.81	
2001	WINTER	382	3763	110.54	95.78	10.28	0.0329	1.005	0.144	2.736	328.5	3.29	
2001	SPRING	314	12057	432.28	52.34	9.66	0.0213	1.257	0.254	2.591	1665.9	2.13	
2001	SUMMER	262	3611	92.88	25.30	4.57	0.0127	0.494	0.098	0.476	126.2	1.26	
2001	FALL	26	79	13.02	6.85	1.40	0.0036	0.029	0.014	0.123	102.0	0.36	78,383
2002	WINTER	32	2176	23.35	10.53	2.89	0.0080	0.237	0.041	0.820	79.6	0.80	133,191
2002	SPRING	240	391	78.64	29.33	5.53	0.0147	0.117	0.059	0.249	146.7	1.47	49,578
2002	SUMMER	36	785	32.54	14.73	3.83	0.0124	0.204	0.036	0.338	89.3	0.73	259,049
2002	FALL	328	14196	114.33	100.82	13.02	0.0420	1.561	0.242	5.513	415.3	4.15	353,643
2003	WINTER	1188	40797	910.53	189.83	38.17	0.1570	6.267	0.695	11.474	1570.0	15.70	2,638,188
2003	SPRING	588	12050	12.46	82.72	10.48	0.0388	1.553	0.258	4.540	388.2	3.88	1,126,226
2003	SUMMER	905	3351	259.61	72.37	6.47	0.0490	1.506	0.326	1.958	489.6	4.90	1,359,211
2003	FALL	793	3812	476.06	48.38	13.84	0.0543	1.140	0.217	1.914	542.8	5.43	989,502
2004	WINTER	550	3750	871.75	47.22	12.53	0.1180	0.965	1.180	5.993	1180.4	9.98	428,846
2004	SPRING	1111	9725	687.94	778.19	30.35	0.1261	1.582	1.261	6.904	1261.5	12.37	1,305,019
2004	SUMMER	683	12740	547.96	348.55	45.95	0.1084	1.240	1.084	5.351	1084.0	9.34	1,519,492
2004	FALL	1701	1844	454.29	49.02	13.18	0.1225	1.062	1.225	4.902	1225.4	3.60	844,942

Seasonal loads (lbs/season) were calculated from data using half of the detection limit (DL) for concentrations less than the DL.

* million MPN/season

Comparison of Total Phosphorus Data to Non-Point Source (NPS) Data

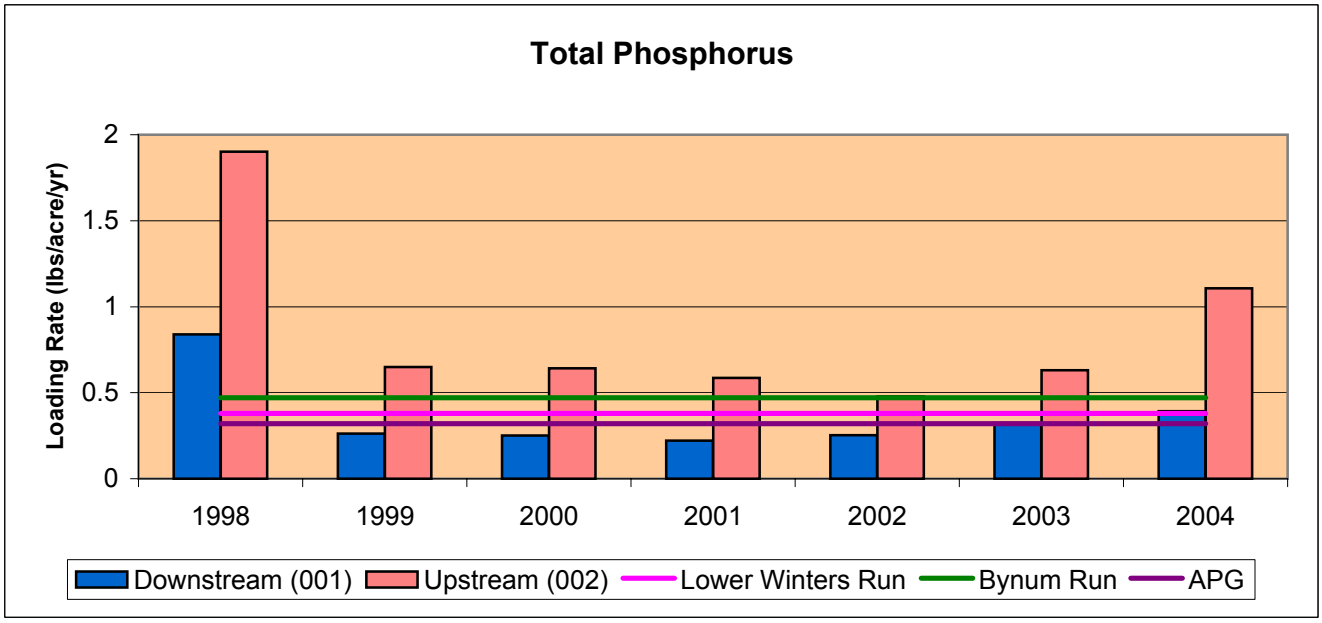
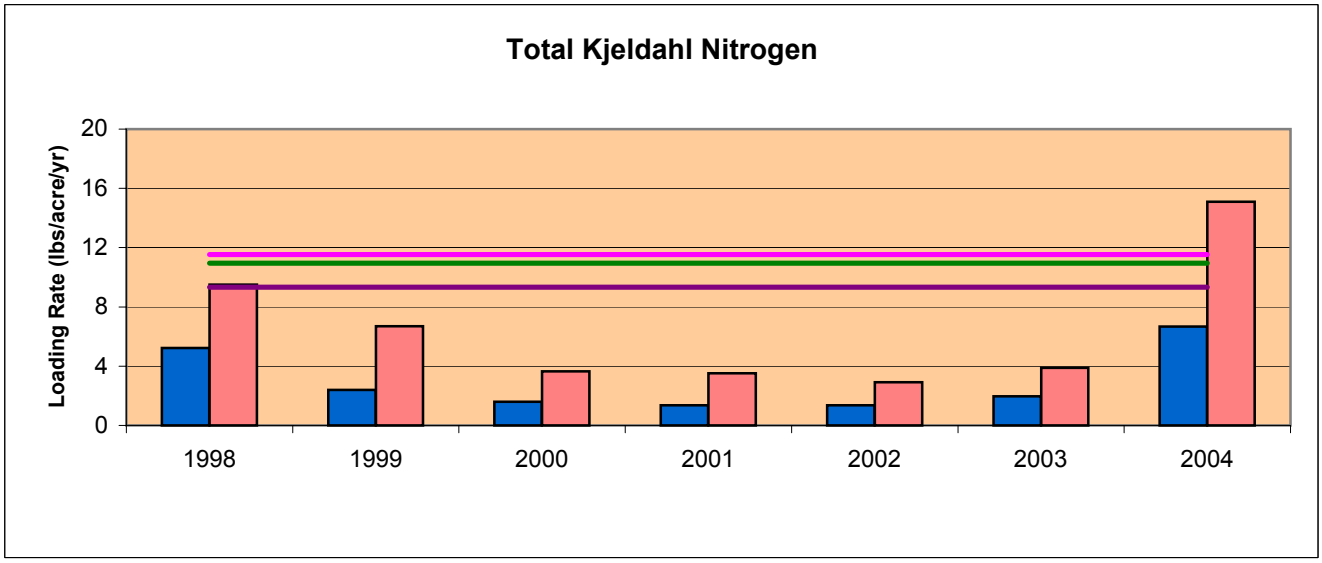


Figure 13. Total phosphorus loading rates (lbs/acre/yr) of the upstream (outfall) and downstream (instream) station compared to phosphorus loading rates (lbs/acre) of the Aberdeen Proving Ground (APG), Bynum Run and Lower Winters Run Watershed. The calculated loading rates were derived using one half of the detection limit (DL) for concentrations less than the DL. The information was dowloaded from the website: http://www.dnr.state.md.us/bay/czm/nps/.

Comparison of Total Kjeldahl Nitrogen and Nitrate + Nitrite Data to Non-Point Source (NPS) Data



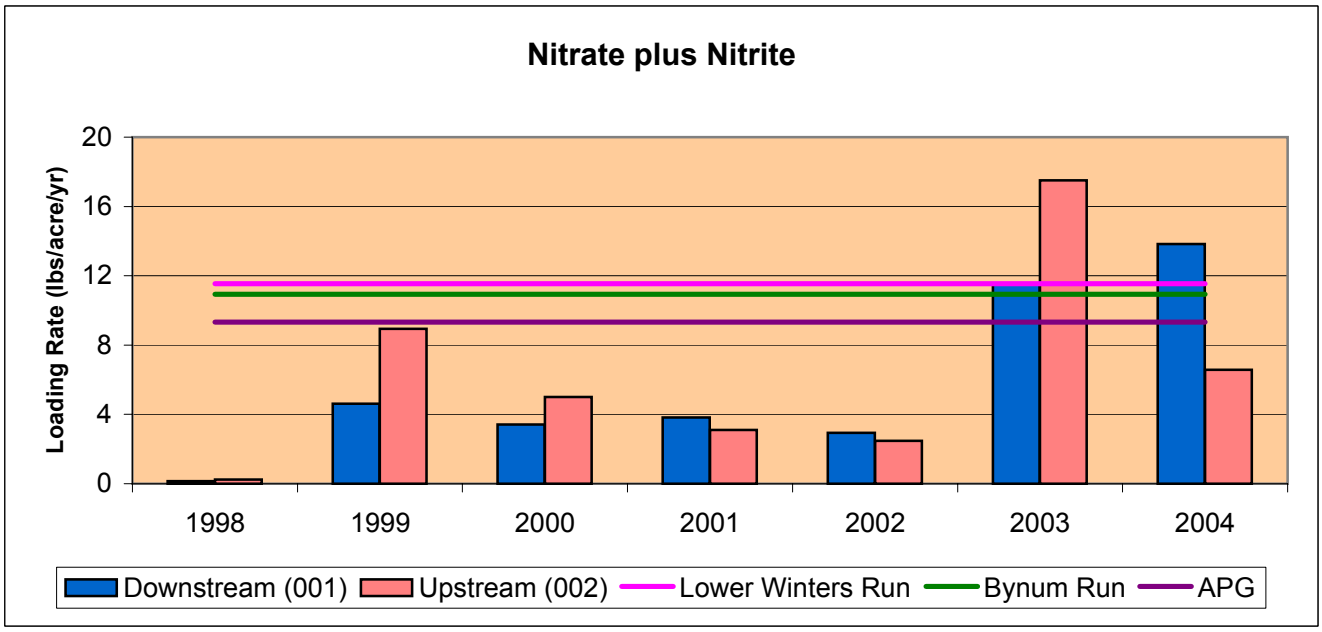


Figure 14. Total kjeldahl nitrogen and nitrate plus nitrite loading rates (lbs/acre/yr) of the upstream (outfall) and downstream (instream) station compared to total nitrogen loading rates (lbs/acre) of the Aberdeen Proving Ground (APG), Bynum Run and Lower Winters Run Watershed. The calculated loading rates were derived using one half of the detection limit (DL) for concentrations less than the DL. The information was dowloaded from the website: http://www.dnr.state.md.us/bay/czm/nps/.

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Appendix A
Tables

Appendix A-1. Water Quality Data Station 001 (Instream) Baseflow

Date	BOD5 (mg/L)	TSS (mg/L)	NO23 (mg/L)	TKN (mg/L)	TP (mg/L)	Cd (mg/L)	Cu (mg/L)	Pb (mg/L)	Zn (mg/L)	TPH (mg/L)	Phenols (mg/L)	Temp (deg F)	pH	Fecals (MPN/100mL)	Depth (in)	Velocity (ft/s)	Discharge (cfs)
1/29/04 10:00 AM	-999	-999	2.2	-999	-999	-999	0.003	-999	-999	-999	0.01	33.1	7.35	-999	1.55	2.26	0.63
1/29/04 10:30 AM	-999	-999	2.1	-999	-999	-999	-999	-999	-999	-999	0.03	33.1	7.39	NA	2.07	2.11	0.54
1/29/04 11:00 AM	-999	-999	2.5	-999	-999	-999	-999	-999	-999	-999	0.01	33.1	7.37	-999	2.01	2.46	0.75
2/26/04 9:30 AM	-999	-999	2	-999	0.01	-999	-999	-999	-999	-999	0.02	34.9	7.09	NA	1.75	2.3	0.65
2/26/04 10:00 AM	-999	-999	2	-999	0.01	-999	-999	-999	-999	-999	0.03	35.2	7.22	NA	1.84	2.68	0.91
2/26/04 10:30 AM	-999	-999	1.9	-999	-999	-999	-999	-999	-999	-999	0.04	36.1	7.23	NA	1.89	2.55	0.82
3/24/04 9:30 AM	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	47.1	7.61	NA	1.63	2.68	0.9
3/24/04 10:00 AM	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	47.3	7.63	NA	1.76	2.85	1.04
3/24/04 10:30 AM	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	47.7	7.67	NA	1.73	2.66	0.89
4/22/04 9:40 AM	-999	2	1.5	-999	0.07	-999	-999	-999	-999	-999	0.01	57.6	7.53	NA	2.3	3.15	1.25
4/22/04 10:10 AM	-999	-999	1.5	-999	0.08	-999	-999	-999	-999	-999	0.01	58.6	7.66	NA	2.27	2.57	0.82
4/22/04 10:40 AM	-999	2	1.5	1	0.11	-999	-999	-999	0.02	-999	0.01	60.3	7.76	NA	2.28	2.41	0.72
5/4/04 9:40 AM	-999	5.5	1.4	-999	0.03	-999	-999	-999	-999	-999	-999	63.1	7.39	NA	1.87	2.62	0.86
5/4/04 10:10 AM	-999	4.5	1.4	-999	0.02	-999	-999	-999	-999	-999	0.01	63.5	7.09	NA	2.05	2.57	0.83
5/4/04 10:40 AM	2	5.5	1.4	-999	0.02	-999	-999	-999	-999	-999	0.02	63.9	7.22	NA	1.97	2.68	0.9
6/24/04 9:45 AM	-999	4.5	1.2	3.1	0.03	-999	0.005	-999	-999	-999	0.02	65.7	7.28	NA	1.25	2.74	0.95
6/24/04 10:15 AM	-999	3.5	1.2	2.8	0.02	-999	0.005	-999	-999	-999	0.03	64	7.57	NA	1.29	2.61	0.86
6/24/04 10:45 AM	-999	7	1.2	2.8	0.02	-999	-999	-999	-999	-999	-999	65.8	7.39	NA	1.43	2.74	0.95
8/26/04 9:10 AM	-999	2.4	1.2	-999	0.02	-999	-999	-999	-999	-999	0.03	66.4	7.64	NA	0.86	2.25	0.62
8/26/04 9:40 AM	-999	2.4	1.3	-999	0.01	-999	-999	-999	-999	-999	0.04	67.5	7.54	NA	0.7	2.24	0.59
8/26/04 10:10 AM	-999	2.8	1.4	-999	0.01	-999	-999	-999	-999	-999	0.01	66.4	7.52	NA	0.91	2.29	0.65
9/21/04 9:30 AM	-999	-999	1.2	-999	0.02	-999	0.002	-999	-999	-999	0.05	56.5	7.31	NA	0.76	1.85	0.41
9/21/04 10:00 AM	-999	3.5	1.1	-999	0.03	-999	-999	-999	-999	-999	0.01	56.8	7.36	NA	0.78	2.05	0.51
9/21/04 10:30 AM	-999	-999	1.1	-999	0.05	-999	-999	-999	-999	-999	0.01	57	7.47	NA	0.86	2.08	0.53
11/2/04 10:20 AM	-999	-999	0.78	-999	0.02	-999	0.002	-999	-999	-999	-999	53.6	7.32	NA	1.24	2.49	0.77
11/2/04 10:50 AM	-999	-999	0.78	-999	0.01	-999	-999	-999	-999	-999	-999	54	7.41	NA	1.26	2.32	0.66
11/2/04 11:20 AM	-999	3	0.77	-999	0.01	-999	-999	-999	-999	-999	-999	54.7	7.45	NA	1.32	2.43	0.74
11/30/04 10:30 AM	-999	-999	1.3	-999	0.01	-999	-999	-999	-999	-999	-999	44.6	6.72	NA	2.37	2.61	0.85
11/30/04 11:00 AM	-999	-999	1.5	-999	0.01	-999	-999	-999	-999	-999	-999	45.1	6.82	NA	2.42	2.81	1
11/30/04 11:30 AM	-999	-999	1.6	-999	0.02	-999	-999	-999	-999	-999	-999	46	6.92	NA	2.32	2.57	0.83

Appendix A-2. Water Quality Data Station 001 (Instream) Stormflow

Date	BOD5 (mg/L)	TSS (mg/L)	NO23 (mg/L)	TKN (mg/L)	TP (mg/L)	Cd (mg/L)	Cu (mg/L)	Pb (mg/L)	Zn (mg/L)	TPH (mg/L)	Phenols (mg/L)	Temp (deg F)	pH	Fecals (MPN/100mL)	Depth (in)	Velocity (ft/s)	Discharge (cfs)
3/16/04 8:20 AM	-999	2.4	1.8	-999	0.03	-999	-999	-999	-999	-999	0.01	39.2	6.98	NA	NR	2.52	0.79
3/16/04 11:45 AM	2.4	14	1.6	-999	0.02	-999	0.003	-999	-999	-999	0.01	37.9	6.86	NA	NR	3.51	1.61
3/16/04 3:00 PM	-999	28	1.5	-999	0.09	-999	0.004	-999	0.02	-999	0.02	37.9	6.86	NA	NR	4.52	2.76
3/16/04 4:55 PM	-999	9.6	1.3	-999	0.04	-999	0.003	-999	0.02	-999	0.03	38.1	6.89	NA	NR	4.24	2.4
6/4/04 10:15 PM	-999	10	1.7	1.4	0.05	-999	-999	-999	-999	-999	0.01	61.5	7.26	NR	NR	2.01	0.48
6/5/04 4:25 AM	4.2	110	0.25	2.8	0.77	-999	0.005	-999	0.05	-999	0.09	60.1	7.02	NR	NR	2.6	0.81
6/5/04 7:25 AM	8	150	0.7	3.4	0.57	-999	0.009	-999	0.03	-999	0.01	62.4	7.22	NR	NR	6.54	5.81
6/5/04 10:38 AM	5.6	36	0.83	1.7	0.14	-999	0.004	-999	-999	-999	0.01	60.1	7.23	NR	NR	5.17	3.93
6/10/04 6:50 PM	-999	14	1.6	-999	0.1	-999	-999	-999	-999	-999	0.04	72.5	7.49	NA	NR	2.46	0.75
6/10/04 7:50 PM	-999	9	1.4	1.2	0.12	-999	-999	-999	-999	-999	0.06	72.1	7.4	NA	NR	3.13	1.25
6/10/04 10:30 PM	-999	8	1.3	1.2	0.06	-999	-999	-999	-999	-999	0.01	68.5	7.39	NA	NR	2.76	0.96
6/22/04 6:45 PM	3.1	50	1.2	2.7	0.1	-999	0.006	-999	0.03	-999	0.03	68	7.32	NA	NR	3.28	1.39
6/22/04 7:20 PM	3.4	15	1.3	2.7	0.06	-999	0.004	-999	-999	-999	0.03	68.9	7.4	NA	NR	1.04	2.87
6/22/04 8:15 PM	3.1	28	1.5	3.1	0.08	-999	0.005	-999	-999	-999	0.06	66.9	7.53	NA	NR	2.64	0.87
9/8/04 3:46 PM	4.9	220	1.6	3.4	0.28	-999	0.01	-999	0.03	-999	0.01	71.4	7.07	NA	NR	3.41	1.51
9/8/04 4:26 PM	-999	100	1.6	1.6	0.51	-999	0.007	-999	0.02	-999	-999	71.2	7.16	NA	NR	3.91	2.02
9/8/04 5:41 PM	-999	26	1.4	1.3	0.14	-999	0.004	-999	-999	-999	-999	70.2	6.88	NA	NR	3.3	1.41
9/28/04 8:46 AM	3.6	2	1.1	0.9	0.02	-999	-999	-999	-999	-999	0.03	64.8	7.1	NA	NR	2.26	0.63
9/28/04 9:16 AM	3.8	2.5	1.2	0.6	0.006	-999	0.003	-999	-999	-999	0.02	64	7.3	NA	NR	2.46	0.75
9/28/04 12:11 PM	-999	-999	1	0.7	0.01	-999	-999	-999	-999	-999	0.04	64.8	7.01	NA	NR	2.47	0.76
11/4/04 10:05 AM	-999	-999	0.82	-999	-999	-999	0.002	-999	-999	-999	0.01	48.6	7.06	NA	NR	1.72	0.35
11/4/04 12:55 PM	15	12	0.51	-999	0.07	-999	0.003	-999	-999	-999	0.01	48.7	7.31	NA	NR	5.15	3.63
11/4/04 3:50 PM	9.4	-999	0.5	-999	0.02	-999	0.003	-999	-999	-999	0.02	49.1	6.69	NA	NR	3.88	1.99
11/12/04 6:25 AM	-999	3.5	1.1	-999	0.01	-999	-999	-999	-999	-999	0.01	44.8	7.13	NA	NR	1.91	0.43
11/12/04 9:05 AM	5.9	4	1.2	-999	0.05	-999	0.005	-999	-999	-999	0.01	46.2	7.12	NA	NR	3.32	1.43
11/12/04 3:55 PM	6.7	6.5	0.51	-999	0.03	-999	0.003	-999	-999	-999	0.01	46.2	6.78	NA	NR	4.62	2.88
12/23/04 7:15 AM	-999	11	1.6	-999	-999	-999	-999	-999	-999	-999	-999	41.18	6.49	NR	NR	-999	NR
12/23/04 12:20 PM	-999	120	1	1.4	0.08	-999	0.007	-999	-999	-999	-999	43.34	7.02	NR	NR	-999	NR
12/23/04 2:15 PM	-999	31	0.62	1.7	0.08	-999	0.004	-999	-999	-999	0.01	43.34	6.99	NA	NR	-999	NR
11/30/04 11:30 AM	-999	-999	1.6	-999	0.02	-999	-999	-999	-999	-999	-999	46	6.92	NA	2.32	2.57	0.83

-999 represents non-deteted concentrations

Appendix A-3. Water Quality Data Station 002 (Outfall) Baseflow

Date	BOD5 (mg/L)	TSS (mg/L)	NO23 (mg/L)	TKN (mg/L)	TP (mg/L)	Cd (mg/L)	Cu (mg/L)	Pb (mg/L)	Zn (mg/L)	TPH (mg/L)	Phenols (mg/L)	Temp (deg F)	pH	Fecals (MPN/100mL)	Depth (in)	Velocity (ft/s)	Discharge (cfs)
1/29/04 11:35 AM	-999	-999	2.3	-999	-999	-999	-999	-999	0.04	-999	-999	32.4	6.08	-999	1.28	1.61	0.23
1/29/04 12:05 PM	-999	-999	2.3	-999	-999	-999	-999	-999	0.04	-999	0.03	32.5	7.58	-999	1.3	1.66	0.23
1/29/04 12:35 PM	-999	-999	2.2	-999	-999	-999	-999	-999	0.04	-999	0.02	32.2	7.33	-999	1.25	1.66	0.23
2/26/04 11:20 AM	-999	-999	1.7	-999	0.03	-999	-999	-999	-999	-999	0.1	33.8	7.26	-999	1.75	1.82	0.28
2/26/04 11:50 AM	-999	-999	1.7	-999	0.03	-999	-999	-999	-999	-999	0.02	34.3	7.55	NA	1.73	1.82	0.28
2/26/04 12:20 PM	-999	-999	1.7	1.4	-999	-999	-999	-999	-999	-999	0.04	35	7.91	NA	2.02	1.82	0.28
3/24/04 11:00 AM	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	47.3	7.84	-999	1.4	1.82	0.28
3/24/04 11:30 AM	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	47.9	7.69	-999	1.32	1.82	0.28
3/24/04 12:00 PM	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	49.1	7.52	-999	1.44	1.82	0.28
4/22/04 11:30 AM	-999	-999	0.5	-999	0.07	-999	-999	-999	-999	-999	0.01	63.3	7.08	NA	1.57	1.45	0.17
4/22/04 12:00 PM	-999	-999	0.53	-999	0.07	-999	-999	-999	-999	-999	0.02	64.6	6.99	NA	1.63	2.51	0.49
4/22/04 12:30 PM	-999	-999	0.5	-999	0.06	-999	-999	-999	-999	-999	0.05	66	6.92	NA	1.42	2.19	0.41
5/4/04 11:40 AM	2.9	-999	0.12	-999	0.03	-999	-999	-999	-999	-999	0.01	69.1	8.06	NA	1.17	2.1	0.38
5/4/04 12:10 PM	-999	-999	0.12	1.9	0.02	-999	-999	-999	-999	-999	0.04	69.8	8.14	NA	0.92	2.06	0.36
5/4/04 12:40 PM	-999	-999	0.12	-999	0.03	-999	-999	-999	-999	-999	0.01	70.5	8.06	NA	1.12	2.06	0.36
6/24/04 11:45 AM	-999	4.5	-999	2.2	0.03	-999	-999	-999	-999	-999	0.03	66.6	7.16	NA	1.13	2.15	0.4
6/24/04 12:15 PM	-999	5	-999	3.1	0.05	-999	-999	-999	-999	-999	0.01	67	7.35	NA	1.3	2.19	0.41
6/24/04 12:45 PM	-999	5	-999	3.1	0.05	-999	-999	-999	-999	-999	0.01	67.3	7.26	NA	1.41	2.15	0.4
8/26/04 10:40 AM	-999	8	0.05	-999	0.01	-999	-999	-999	-999	-999	0.03	65.2	6.98	NA	0.87	0.52	0.02
8/26/04 11:10 AM	-999	8	0.06	-999	0.05	-999	-999	-999	-999	-999	0.04	65.6	6.98	NA	1.1	0.56	0.02
8/26/04 11:40 AM	-999	8	0.05	-999	0.02	-999	-999	-999	-999	-999	0.04	64.8	6.98	NA	0.89	0.52	0.02
9/21/04 10:50 AM	-999	3.5	-999	-999	0.04	-999	-999	-999	-999	-999	0.07	59	7.09	NA	0.2	0.97	0.07
9/21/04 11:20 AM	-999	-999	-999	-999	0.07	-999	-999	-999	-999	-999	0.02	58.6	6.82	NA	0.33	1.02	0.08
9/21/04 11:50 AM	-999	3	-999	-999	0.06	-999	-999	-999	-999	-999	0.03	58.5	6.89	NA	0.2	0.97	0.07
11/2/04 11:40 AM	-999	-999	0.06	-999	0.01	-999	-999	-999	-999	-999	0.01	53.8	6.96	NA	1.56	0.5	0.02
11/2/04 12:10 PM	-999	-999	0.07	-999	0.01	-999	-999	-999	-999	-999	-999	46.2	7.21	NA	2.75	1.06	0.09
11/2/04 12:40 PM	-999	-999	0.07	-999	0.02	-999	-999	-999	-999	-999	-999	42.8	7.26	NA	1.01	1.06	0.09
11/30/04 12:15 PM	3.8	-999	1.2	-999	-999	-999	0.002	-999	-999	-999	-999	44.2	6.26	NA	1.8	0.75	0.04
11/30/04 12:45 PM	-999	-999	1.2	-999	0.01	-999	-999	-999	-999	-999	-999	43.9	6.27	NA	1.88	1.78	0.27
11/30/04 1:15 PM	-999	-999	1.2	-999	0.01	-999	-999	-999	-999	-999	-999	44.1	6.42	NA	1.79	1.74	0.25

-999 represents non-deteted concentrations

Appendix A-4. Water Quality Data Station 002 (Outfall) Stormflow

Date	BOD5 (mg/L)	TSS (mg/L)	NO23 (mg/L)	TKN (mg/L)	TP (mg/L)	Cd (mg/L)	Cu (mg/L)	Pb (mg/L)	Zn (mg/L)	TPH (mg/L)	Phenols (mg/L)	Temp (deg F)	pH	Fecals (MPN/100mL)	Depth (in)	Velocity (ft/s)	Discharge (cfs)
3/16/04 8:00 AM	2.4	-999	1.1	-999	0.03	-999	0.003	-999	0.02	-999	0.04	37.1	7.76	NA	1.61	2.21	0.42
3/16/04 11:30 AM	-999	7	1.1	-999	0.05	-999	0.003	-999	0.02	-999	0.01	37.3	8.04	NA	2.66	1.92	0.31
3/16/04 2:45 PM	-999	4.8	1	-999	0.02	-999	0.003	-999	-999	-999	0.01	37.7	8.01	NA	3.2	1.96	1.96
3/16/04 4:40 PM	-999	2.4	0.92	-999	0.01	-999	0.003	-999	-999	-999	0.02	37.8	7.92	NA	2.41	1.82	0.27
6/4/04 10:00 PM	-999	8	-999	1.7	0.07	-999	-999	-999	-999	-999	-999	63.1	7.53	NR	1.07	2.06	0.36
6/5/04 4:02 AM	-999	10	1.7	1.4	0.05	-999	-999	-999	-999	-999	0.01	61.7	7.56	NR	0.83	1.45	0.17
6/5/04 7:00 AM	5.6	91	0.35	2.8	0.28	-999	0.006	-999	0.04	-999	0.02	61.1	7.83	NR	2.96	1.81	0.28
6/5/04 10:30 AM	3.4	5.5	0.46	2	0.08	-999	0.003	-999	-999	-999	-999	61.4	7.26	NR	2.32	1.62	0.21
6/10/04 6:42 PM	9.6	300	0.15	2.8	0.41	-999	-999	-999	0.03	-999	0.02	72.8	7.44	NA	1.99	3.23	0.94
6/10/04 7:40 PM	-999	11	0.08	-999	0.41	-999	-999	-999	-999	-999	0.07	72	7.74	NA	2.21	3.6	1.17
6/10/04 10:00 PM	-999	-999	0.2	1.1	0.06	-999	-999	-999	-999	-999	0.01	70.7	7.97	NA	0.95	2.1	0.38
6/22/04 6:35 PM	-999	34	-999	2.5	0.07	-999	-999	-999	-999	-999	0.02	69.2	7.73	NA	0.77	2.17	0.9
6/22/04 7:10 PM	5	16	0.25	3.4	0.09	-999	0.004	-999	0.03	-999	0.03	75.3	6.38	NA	1.27	3.23	0.94
6/22/04 7:50 PM	14	12	0.67	2.8	0.05	-999	-999	-999	-999	-999	0.08	70.9	6.29	NA	1.48	3.69	1.24
9/8/04 3:36 PM	5.3	140	0.54	2.8	0.69	-999	0.01	-999	0.08	-999	0.02	NR	6.61	NA	1.91	3.79	1.31
9/8/04 4:10 PM	87	440	0.4	4.8	0.86	-999	0.004	-999	0.02	-999	0.06	NR	6.74	NA	1.44	2.64	0.61
9/8/04 5:26 PM	-999	10	0.38	1.2	0.11	-999	-999	-999	-999	-999	0.03	NR	6.83	NA	0.96	1.54	0.19
9/28/04 8:30 AM	70	230	0.26	3.9	1.9	-999	0.009	-999	0.15	-999	0.08	NR	6.81	NA	1.22	1.32	0.14
9/28/04 9:00 AM	6.8	16	0.42	0.8	0.03	-999	-999	-999	0.02	-999	0.03	NR	6.86	NA	1.36	1.79	0.26
9/28/04 11:54 AM	12	4	0.12	-999	-999	-999	-999	-999	0.01	-999	0.04	NR	6.96	NA	0.64	1.1	0.09
11/4/04 9:46 AM	-999	13	-999	1.2	0.01	-999	-999	-999	-999	-999	0.01	48.9	7.32	NA	0.95	0.5	0.01
11/4/04 12:34 PM	6.4	2.5	0.33	-999	0.07	-999	0.002	-999	-999	-999	0.01	48.4	7.16	NA	3.08	0.63	0.02
11/4/04 3:38 PM	4.1	-999	0.32	-999	0.04	-999	0.01	-999	0.02	-999	0.01	49.3	7.13	NA	2.35	0.5	0.01
11/12/04 6:00 AM	-999	-999	0.4	-999	0.01	-999	-999	-999	-999	-999	0.01	44.1	6.45	NA	1.06	0.56	0.02
11/12/04 8:54 AM	7.7	26	0.75	1.3	0.07	-999	0.003	-999	0.02	-999	0.01	45	6.46	NA	2.33	0.54	0.02
11/12/04 3:34 PM	6	3.5	0.5	-999	0.04	-999	0.005	-999	-999	-999	0.01	45.7	6.66	NA	3.26	0.78	0.04
12/23/04 6:58 AM	-999	1	1.1	1	-999	-999	-999	-999	0.02	-999	0.03	40.46	6.44	NR	0.57	1.95	0.32
12/23/04 11:58 AM	-999	15	0.59	1.4	0.06	-999	0.002	-999	0.03	-999	0.01	49.64	7.02	NR	3.78	1.35	0.14
12/23/04 1:50 PM	-999	110	0.44	1.5	0.06	-999	0.003	-999	-999	-999	1.5	44.42	7.1	NR	3.58	0.98	0.13
11/30/04 11:30 AM	-999	-999	1.6	-999	0.02	-999	-999	-999	-999	-999	-999	46	6.92	NA	2.32	2.57	0.83

-999 represents non-deteted concentrations

Table A-5. 1998 - 2004 Monthly Rainfall Totals (inches)
Harford County: Trib to Winters Run at Tollgate Road

Month	1998	1999	2000	2001	2002	2003	2004
1	---	4.88	---	2.85	1.78	2.24	0.9
2	---	2.83	1.59	2.4	0.16	1.64	3.2
3	---	3.75	2.52	5.5	2.89	4.6	2.62
4	0.32	2.62	3.22	1.81	2.21	1.87	5.31
5	6.67	1.52	2.74	4.24	2.73	0.83	2.98
6	2.25	2.42	1.91	3.41	3.17	3.38	4.46
7	2.94	2.02	5.77	0	2.1	3.61	7.17
8	5.12	5.74	3.06	3.46	2.63	5.9	2.42
9	1.97	12.84	3.61	4.4	4.46	9.28	6.32
10	2.82	4.14	0.27	0.92	3.74	6.94	2.6
11	1.33	2.74	2.38	1.49	0.25	3.44	5.33
12	0.96	3.4	2.91	1.57	5.25	---	3.3
Total Rainfall (inches)	24.38	48.9	29.98	32.05	31.37	43.73	46.61

--- represents missing data

Table A-6. Comparison of 1998-2003 Event Mean Concentrations (EMCs) with Maryland NPDES EMCs and NURP Residential EMCs

Parameter	Yearly Average EMC (mg/L)	Maryland NPDES (mg/L)	NURP Residential EMCs (mg/L)
1998 Upstream Station (Outfall)			
Biological Oxygen Demand	2.54	14.26	11
Total Suspended Solids	21.14	55.08	140
Nitrate plus Nitrite	NC	0.97	0.96
Total Kjeldahl Nitrogen	0.62	1.75	2.35
Total Phosphorus	0.13	0.37	0.47
Total Petroleum Hydrocarbons	0.002	--	--
Total Phenols	**0.003**	**0.0022**	--
Total Cadmium	NC	0.00004	--
Total Copper	0.004	0.0141	0.05
Total Lead	0.0005	0.0057	0.18
Total Zinc	0.026	0.0893	0.18
1998 Downstream Station (Instream)			
Biological Oxygen Demand	4.22	14.26	11
Total Suspended Solids	**63.63**	**55.08**	140
Nitrate plus Nitrite	NC	0.97	0.96
Total Kjeldahl Nitrogen	0.60	1.75	2.35
Total Phosphorus	0.11	0.37	0.47
Total Petroleum Hydrocarbons	0.076	--	--
Total Phenols	**0.010**	**0.0022**	--
Total Cadmium	NC	0.00004	--
Total Copper	0.003	0.0141	0.05
Total Lead	0.0007	0.0057	0.18
Total Zinc	0.014	0.0893	0.18
1999 Upstream Station (Outfall)			
Biological Oxygen Demand	1.26	14.26	11
Total Suspended Solids	28.13	55.08	140
Nitrate plus Nitrite	**1.31**	**0.97**	**0.96**
Total Kjeldahl Nitrogen	0.40	1.75	2.35
Total Phosphorus	0.14	0.37	0.47
Total Petroleum Hydrocarbons	0.70	--	--
Total Phenols	**0.024**	**0.0022**	--
Total Cadmium	NC	0.00004	
Total Copper	0.003	0.0141	0.05
Total Lead	0.0003	0.0057	0.18
Total Zinc	0.020	0.0893	0.18
Fecal Coliform (MPN/mL)	899.76	2309.12	--
1999 Downstream Station (Instream)			
Biological Oxygen Demand	3.22	14.26	11
Total Suspended Solids	30.90	55.08	140
Nitrate plus Nitrite	**1.30**	**0.97**	**0.96**
Total Kjeldahl Nitrogen	0.46	1.75	2.35
Total Phosphorus	0.05	0.37	0.47
Total Petroleum Hydrocarbons	1.08	--	--
Total Phenols	**0.015**	**0.0022**	--
Total Cadmium	NC	0.00004	--
Total Copper	0.004	0.0141	0.05
Total Lead	0.0005	0.0057	0.18
Total Zinc	0.011	0.0893	0.18
Fecal Coliform (MPN/mL)	852.08	2309.12	

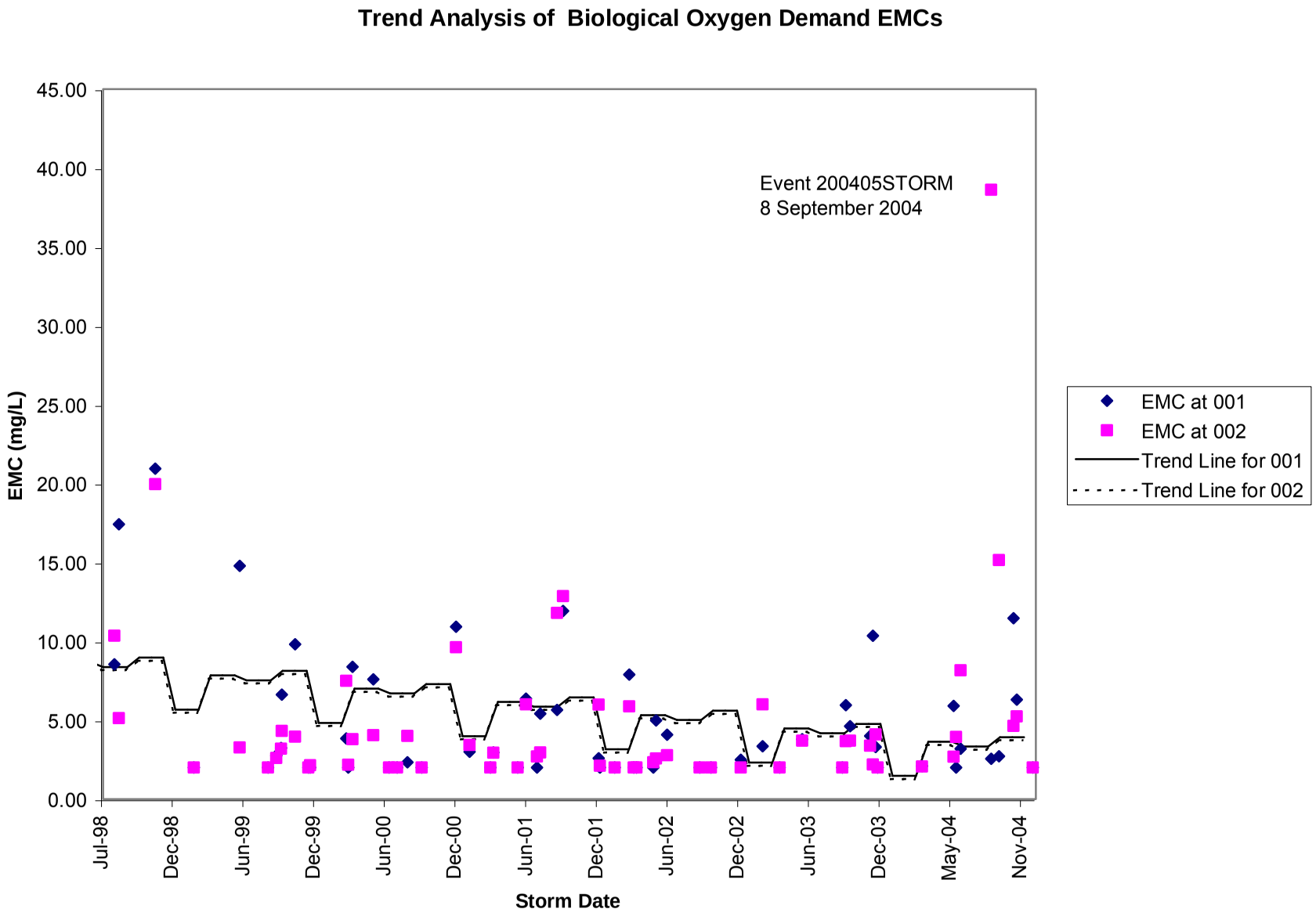
Table A-6. Comparison of 1998-2003 Event Mean Concentrations (EMCs) with Maryland NPDES EMCs and NURP Residential EMCs

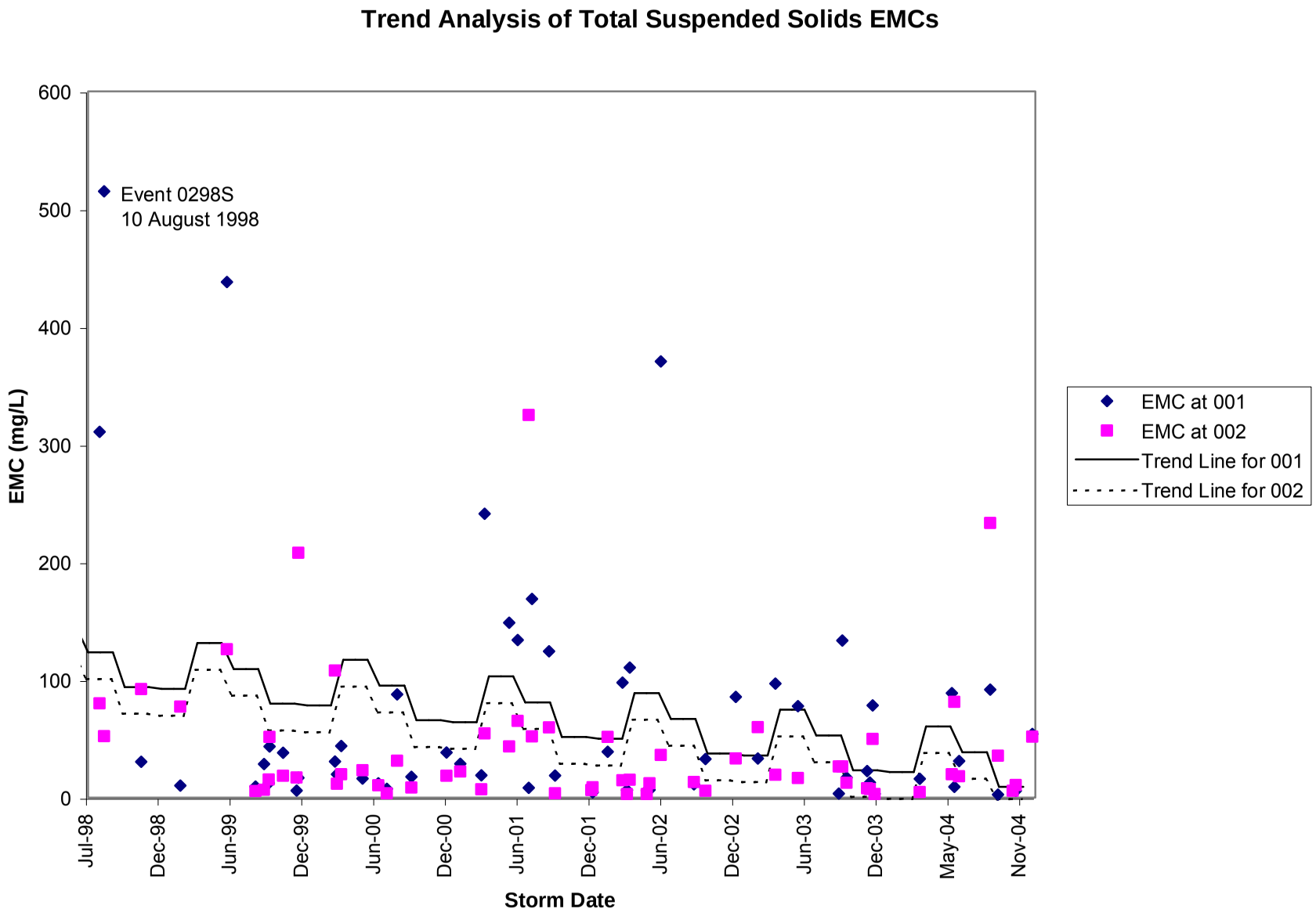
Parameter	Yearly Average EMC (mg/L)	Maryland NPDES (mg/L)	NURP Residential EMCs (mg/L)
2000 Upstream Station (Outfall)			
Biological Oxygen Demand	1.99	14.26	11
Total Suspended Solids	14.94	55.08	140
Nitrate plus Nitrite	0.90	0.97	0.96
Total Kjeldahl Nitrogen	0.34	1.75	2.35
Total Phosphorus	0.10	0.37	0.47
Total Petroleum Hydrocarbons	0.193	--	--
Total Phenols	**0.003**	**0.0022**	--
Total Cadmium	**0.0002**	**0.00004**	--
Total Copper	0.003	0.0141	0.05
Total Lead	0.0002	0.0057	0.18
Total Zinc	0.015	0.0893	0.18
Fecal Coliform (MPN/mL)	222.08	2309.12	--
2000 Downstream Station (Instream)			
Biological Oxygen Demand	1.93	14.26	11
Total Suspended Solids	15.07	55.08	140
Nitrate plus Nitrite	**1.26**	**0.97**	**0.96**
Total Kjeldahl Nitrogen	0.30	1.75	2.35
Total Phosphorus	0.08	0.37	0.47
Total Petroleum Hydrocarbons	0.716	--	--
Total Phenols	NC	0.0022	
Total Cadmium	NC	0.00004	
Total Copper	0.004	0.0141	0.05
Total Lead	0.0003	0.0057	0.18
Total Zinc	0.009	0.0893	0.18
Fecal Coliform (MPN/mL)	104.49	2309.12	
2001 Upstream Station (Outfall)			
Biological Oxygen Demand	2.55	14.26	11
Total Suspended Solids	28.81	55.08	140
Nitrate plus Nitrite	0.66	0.97	0.96
Total Kjeldahl Nitrogen	0.40	1.75	2.35
Total Phosphorus	0.10	0.37	0.47
Total Petroleum Hydrocarbons	5.677	--	--
Total Phenols	**0.026**	**0.0022**	
Total Cadmium	NC	0.00004	
Total Copper	0.003	0.0141	0.05
Total Lead	0.0003	0.0057	0.18
Total Zinc	0.020	0.0893	0.18
Fecal Coliform (MPN/mL)	269.90	2309.12	--
2001 Downstream Station (Instream)			
Biological Oxygen Demand	2.23	14.26	11
Total Suspended Solids	39.17	55.08	140
Nitrate plus Nitrite	**1.68**	**0.97**	**0.96**
Total Kjeldahl Nitrogen	0.20	1.75	2.35
Total Phosphorus	0.08	0.37	0.47
Total Petroleum Hydrocarbons	5.809	--	--
Total Phenols	**0.024**	**0.0022**	
Total Cadmium	0.00002	0.00004	
Total Copper	0.005	0.0141	0.05
Total Lead	0.0007	0.0057	0.18
Total Zinc	0.012	0.0893	0.18
Fecal Coliform (MPN/mL)	324.52	2309.12	

Table A-6. Comparison of 1998-2003 Event Mean Concentrations (EMCs) with Maryland NPDES EMCs and NURP Residential EMCs

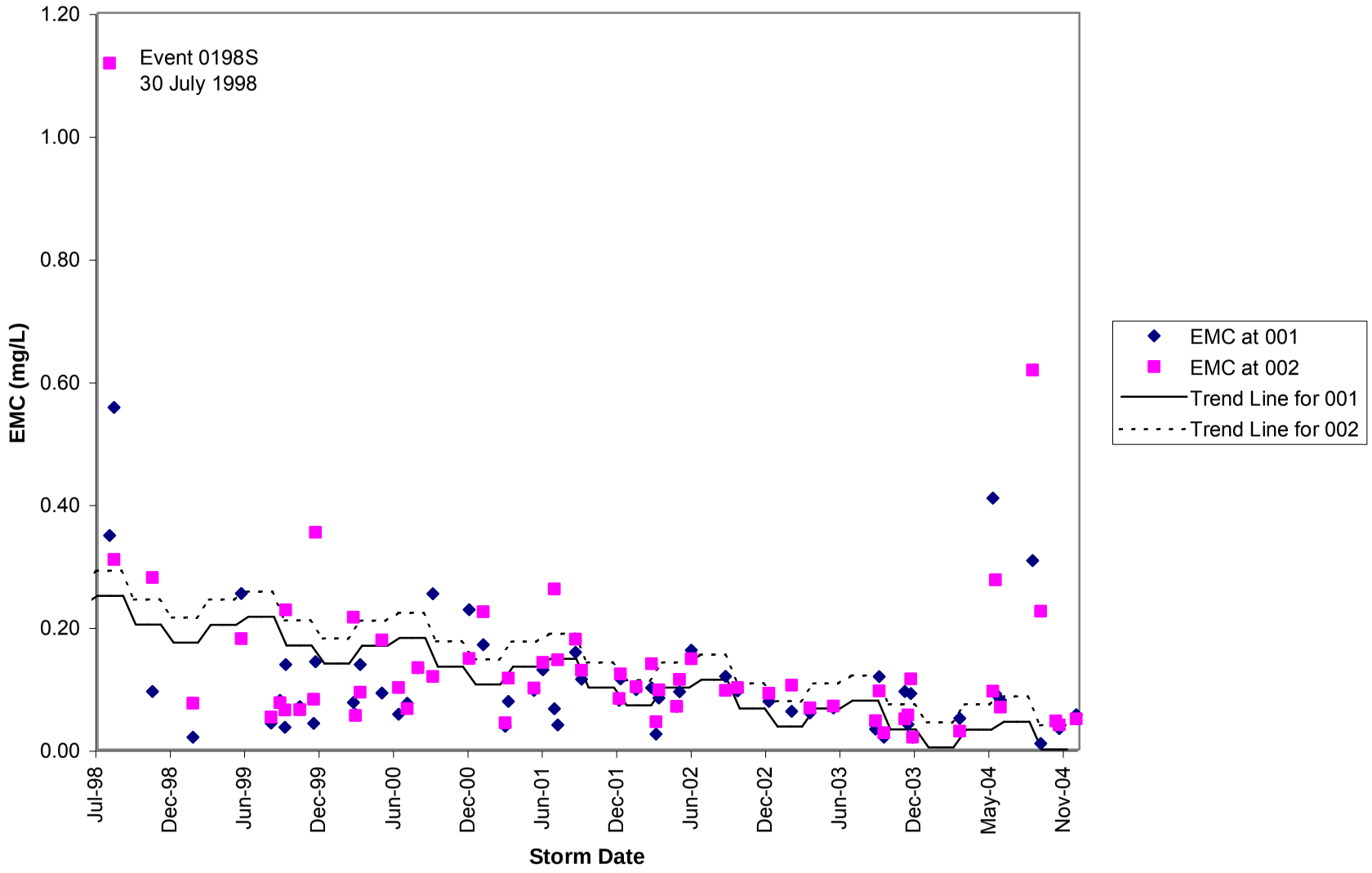
Parameter	Yearly Average EMC (mg/L)	Maryland NPDES (mg/L)	NURP Residential EMCs (mg/L)
2002 Upstream Station (Outfall)			
Biological Oxygen Demand	0.50	14.26	11
Total Suspended Solids	11.97	55.08	140
Nitrate plus Nitrite	0.58	0.97	0.96
Total Kjeldahl Nitrogen	0.38	1.75	2.35
Total Phosphorus	0.08	0.37	0.47
Total Petroleum Hydrocarbons	3.53	--	--
Total Phenols	**0.023**	**0.0022**	
Total Cadmium	0.000002	0.00004	
Total Copper	0.003	0.0141	0.05
Total Lead	0.0002	0.0057	0.18
Total Zinc	0.022	0.0893	0.18
Fecal Coliform (MPN/mL)	660.68	2309.12	--
2002 Downstream Station (Instream)			
Biological Oxygen Demand	0.99	14.26	11
Total Suspended Solids	39.07	55.08	140
Nitrate plus Nitrite	**1.08**	**0.97**	**0.96**
Total Kjeldahl Nitrogen	0.21	1.75	2.35
Total Phosphorus	0.08	0.37	0.47
Total Petroleum Hydrocarbons	3.83	--	--
Total Phenols	**0.024**	**0.0022**	--
Total Cadmium	0.00001	0.00004	
Total Copper	0.005	0.0141	0.05
Total Lead	0.0005	0.0057	0.18
Total Zinc	0.011	0.0893	0.18
Fecal Coliform (MPN/mL)	485.68	2309.12	
2003 Upstream Station (Outfall)			
Biological Oxygen Demand	3.09	14.26	11
Total Suspended Solids	10.97	55.08	140
Nitrate plus Nitrite	**1.37**	**0.97**	**0.96**
Total Kjeldahl Nitrogen	0.25	1.75	2.35
Total Phosphorus	0.04	0.37	0.47
Total Petroleum Hydrocarbons	0.45	--	--
Total Phenols	**0.011**	**0.0022**	--
Total Cadmium	0.00000	0.00004	--
Total Copper	0.004	0.0141	0.05
Total Lead	0.0001	0.0057	0.18
Total Zinc	0.016	0.0893	0.18
Fecal Coliform (MPN/mL)	586.81	2309.12	--
2003 Downstream Station (Instream)			
Biological Oxygen Demand	3.04	14.26	11
Total Suspended Solids	23.06	55.08	140
Nitrate plus Nitrite	**1.62**	**0.97**	**0.96**
Total Kjeldahl Nitrogen	0.14	1.75	2.35
Total Phosphorus	0.04	0.37	0.47
Total Petroleum Hydrocarbons	0.61	--	--
Total Phenols	**0.001**	**0.0022**	--
Total Cadmium	0.11905	0.00004	--
Total Copper	0.005	0.0141	0.05
Total Lead	0.0003	0.0057	0.18
Total Zinc	0.008	0.0893	0.18
Fecal Coliform (MPN/mL)	594.09	2309.12	--

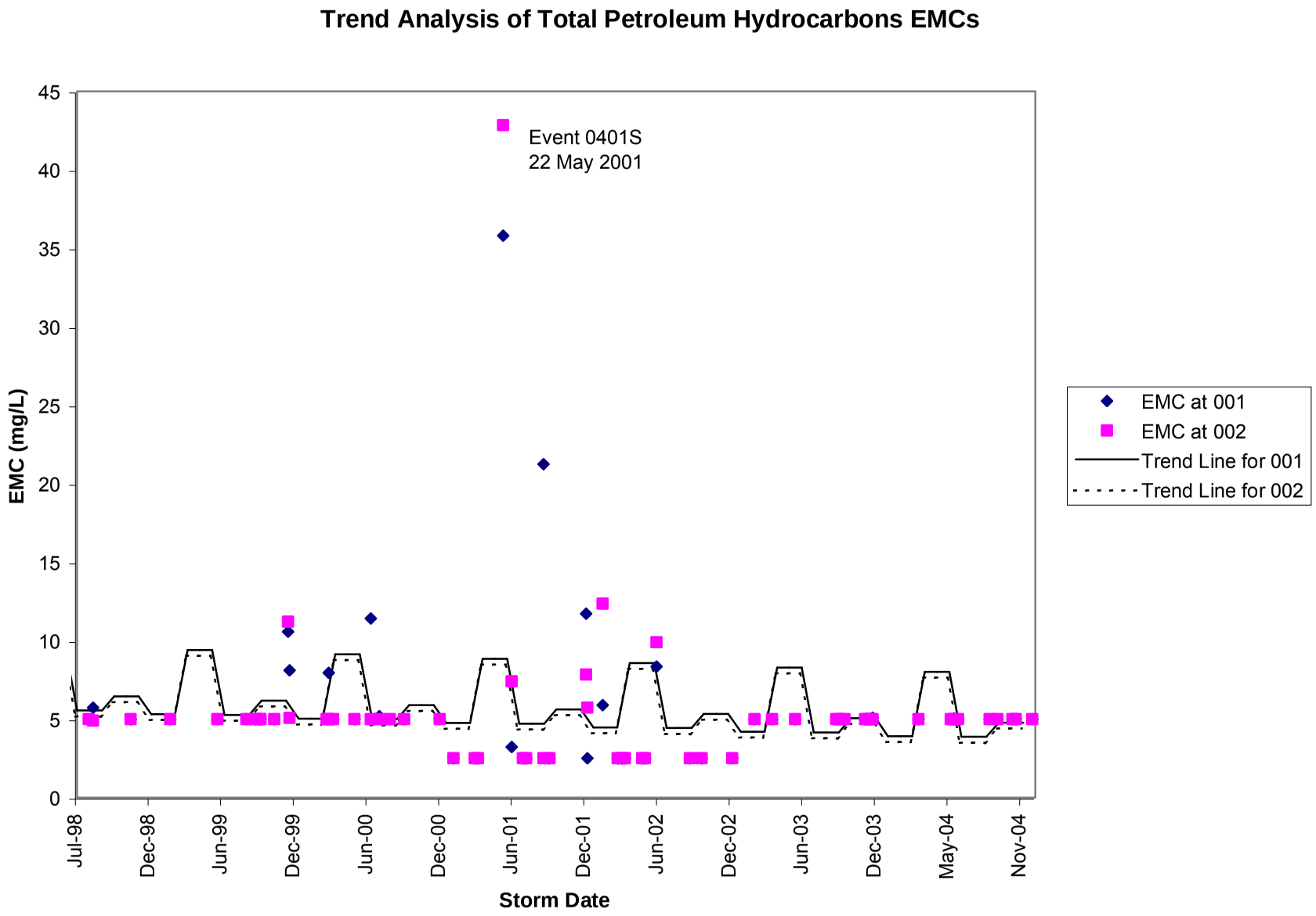
Appendix B
Trend Analysis Graphs

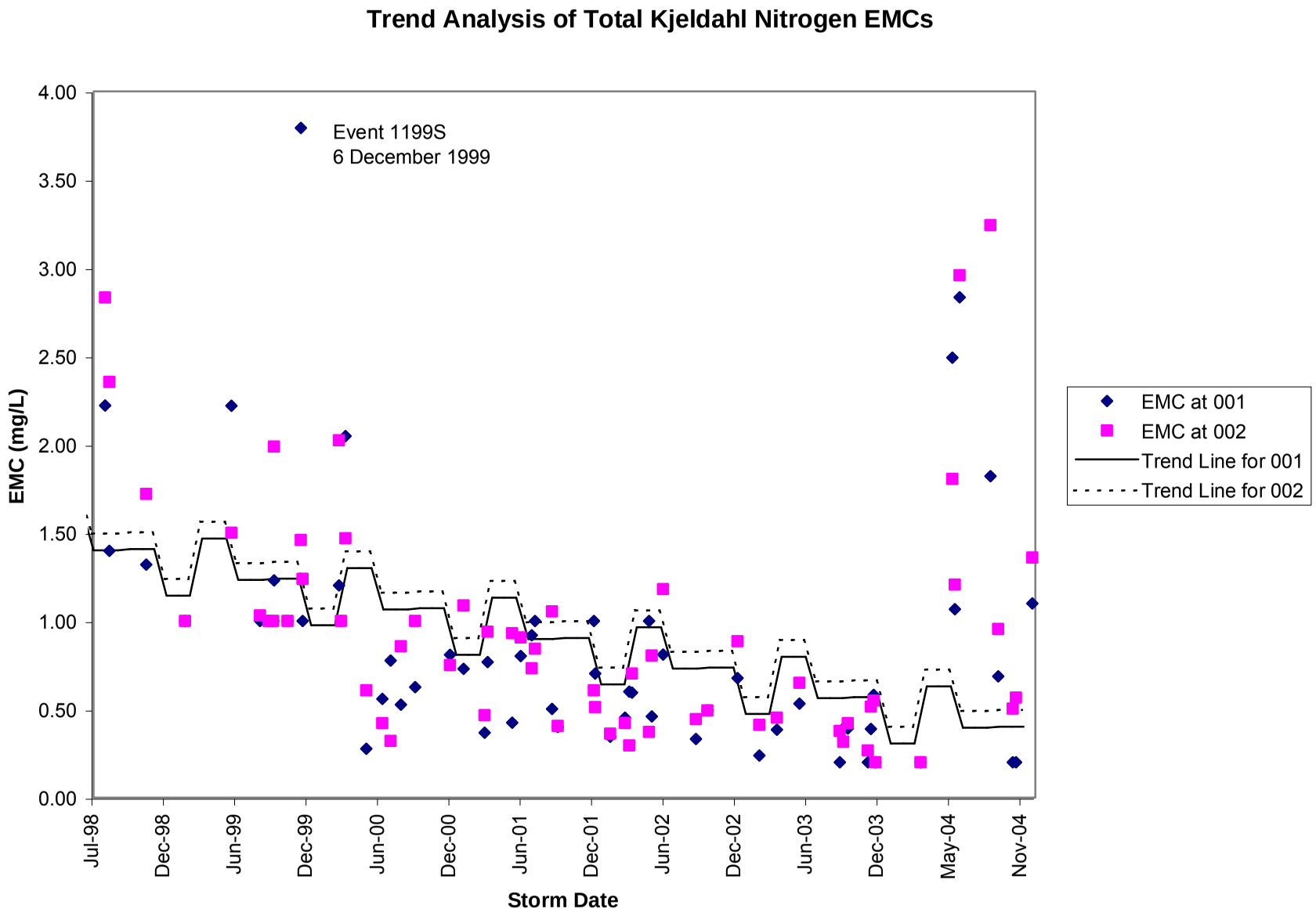

Trend Analysis of Biological Oxygen Demand EMCs
Event 200405STORM
8 September 2004
EMC (mg/L)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Jul-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002

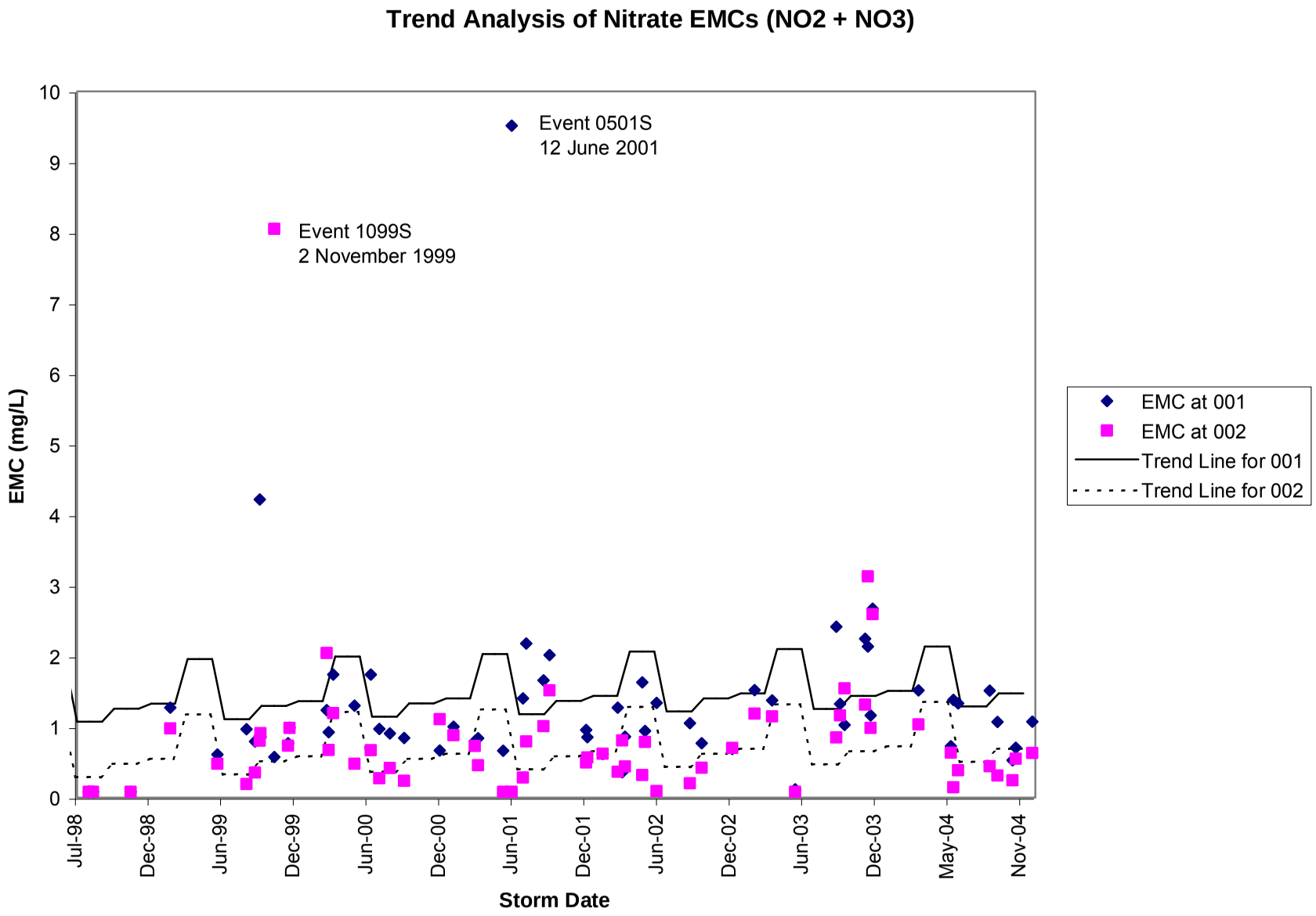

Trend Analysis of Total Suspended Solids EMCs
EMC (mg/L)
600
500
400
300
200
100
0
Event 0298S
10 August 1998
Jul-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002

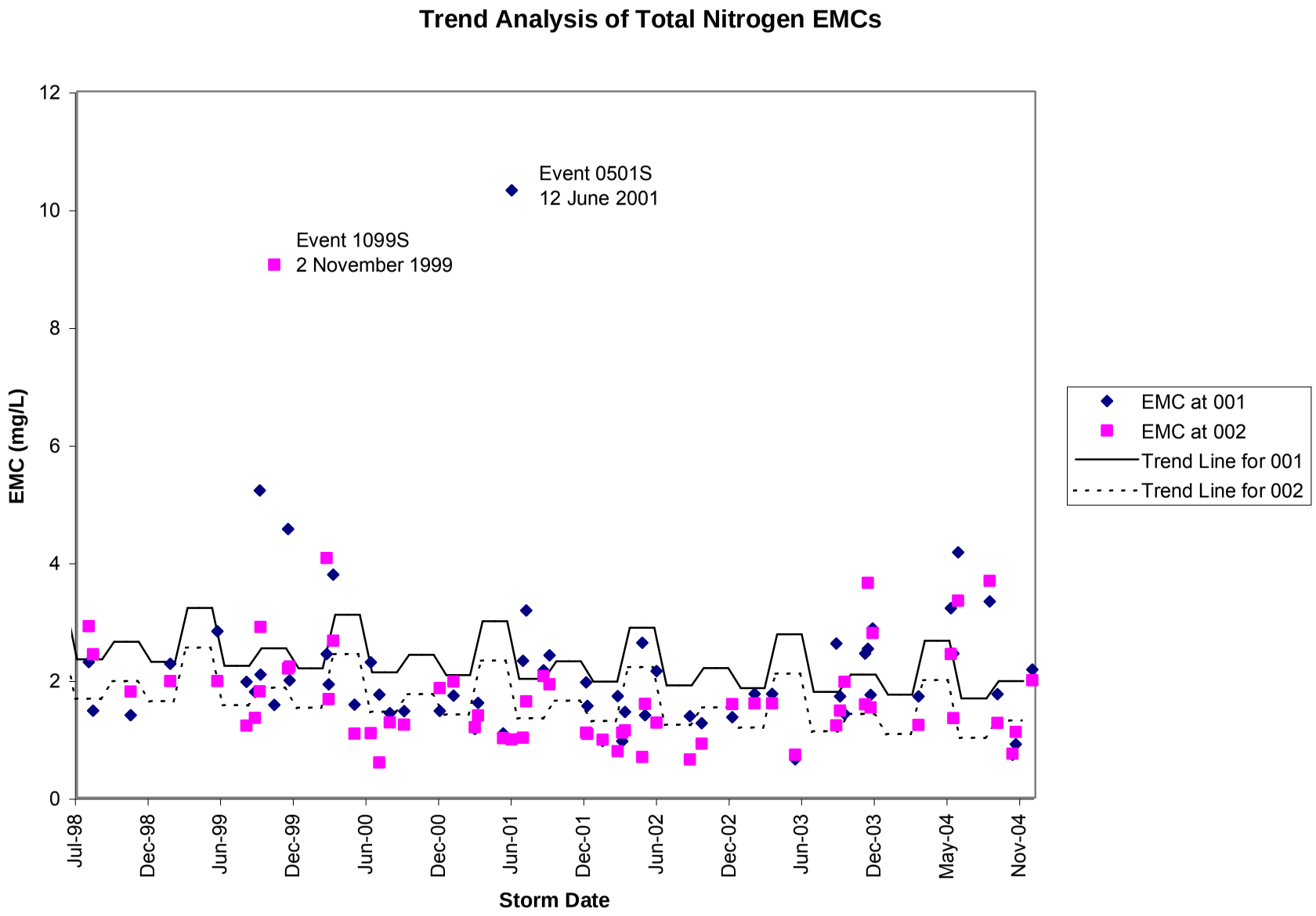
Trend Analysis of Total Phosphorus EMCs



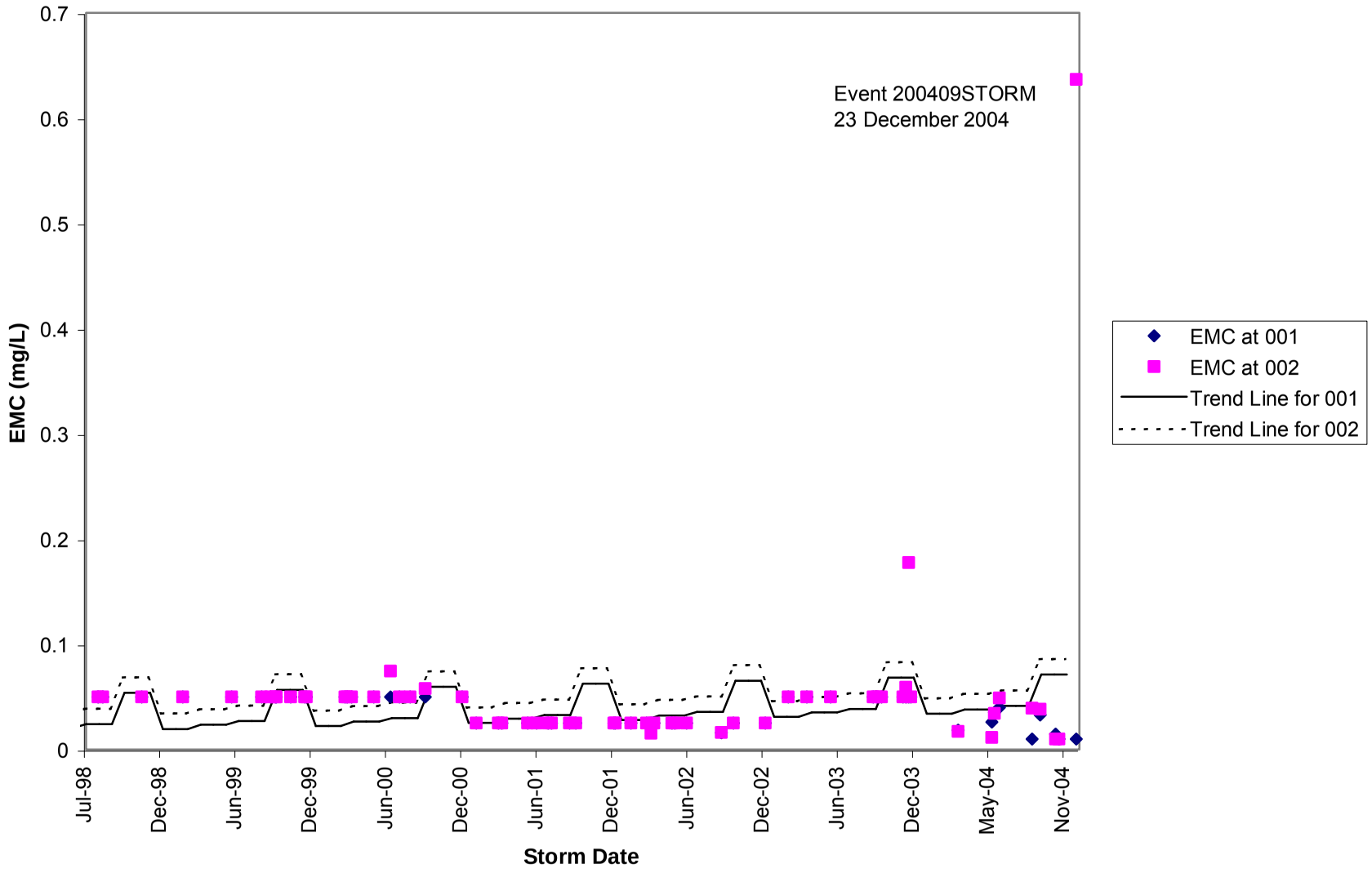

Trend Analysis of Total Petroleum Hydrocarbons EMCs
Event 0401S
22 May 2001
EMC (mg/L)
45
40
35
30
25
20
15
10
5
0
Jul-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002

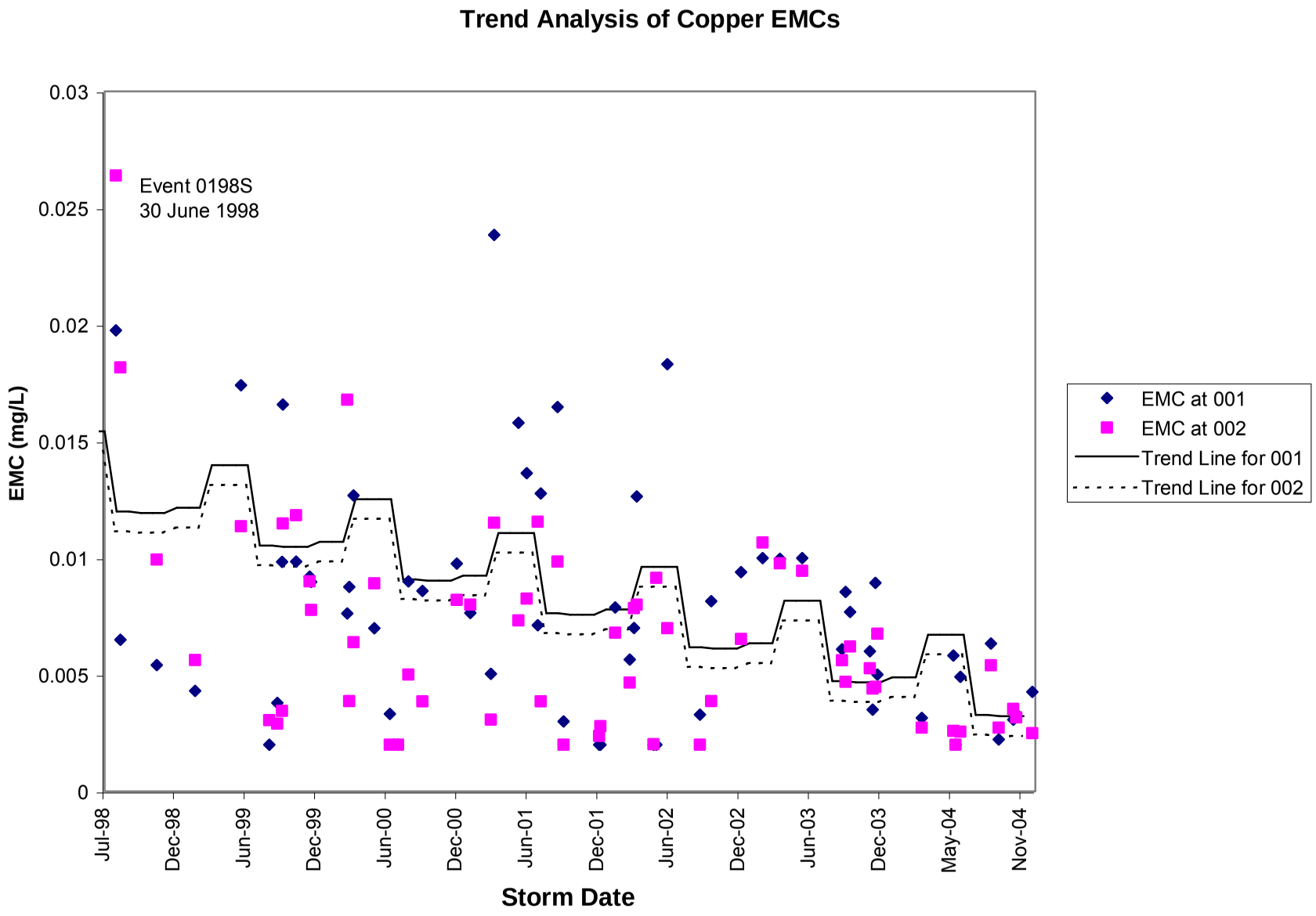

Trend Analysis of Total Kjeldahl Nitrogen EMCs
Event 1199S
6 December 1999
EMC (mg/L)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jul-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002

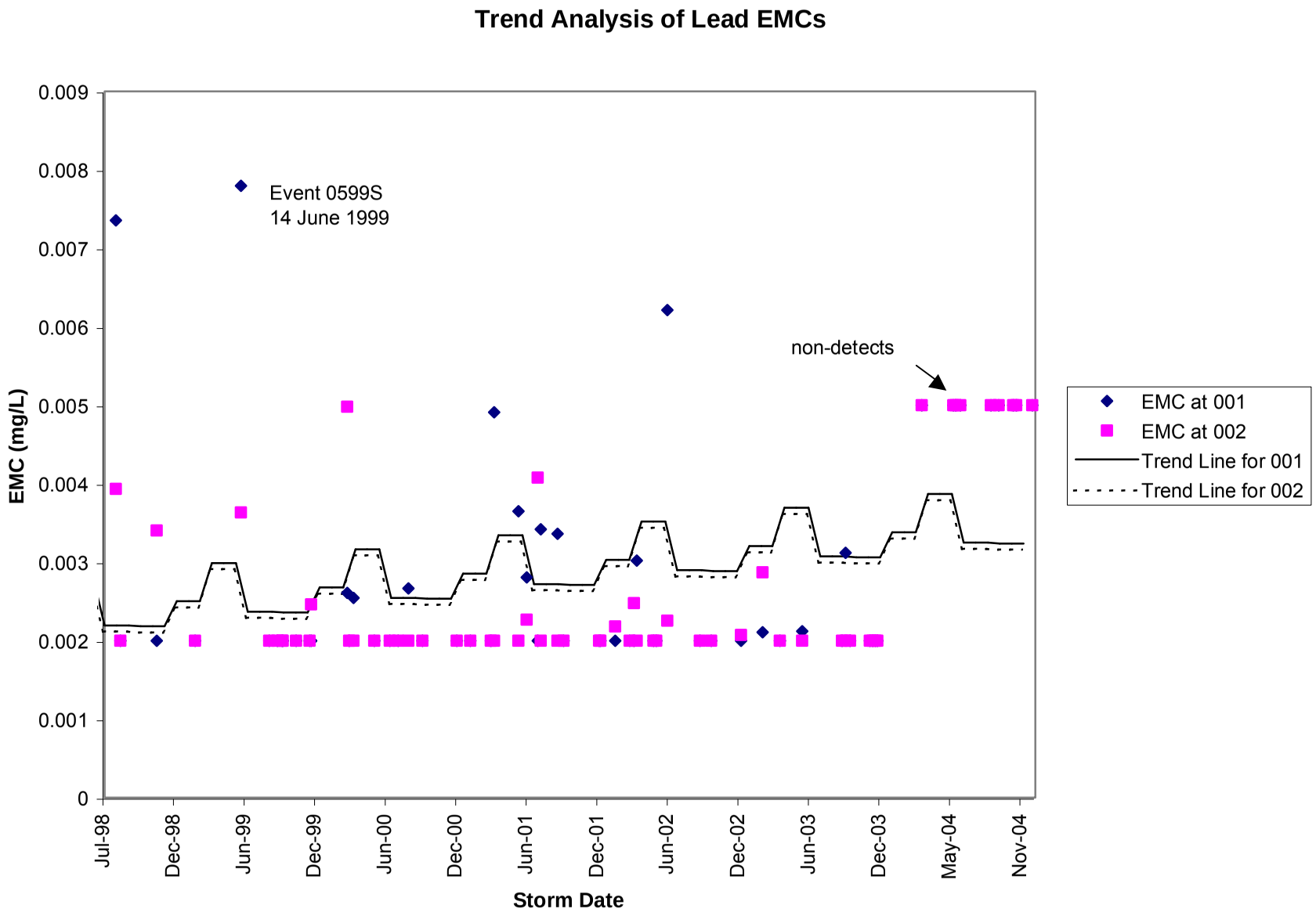

Trend Analysis of Nitrate EMCs (NO2 + NO3)
Event 0501S
12 June 2001
Event 1099S
2 November 1999
EMC (mg/L)
0
1
2
3
4
5
6
7
8
9
10
Jul-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002

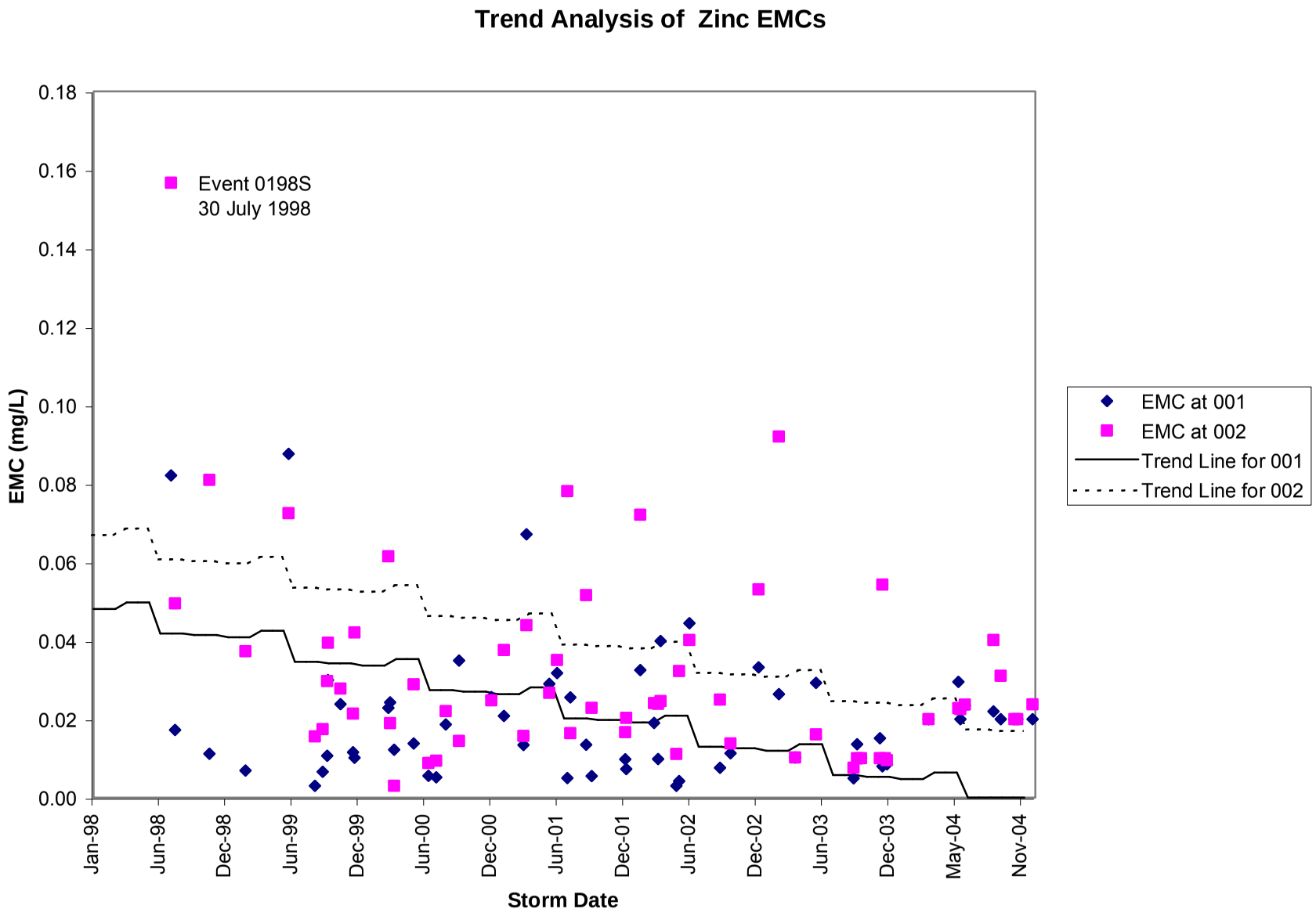

Trend Analysis of Total Nitrogen EMCs
EMC (mg/L)
0
2
4
6
8
10
12
Event 0501S
12 June 2001
Event 1099S
2 November 1999
Jul-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002

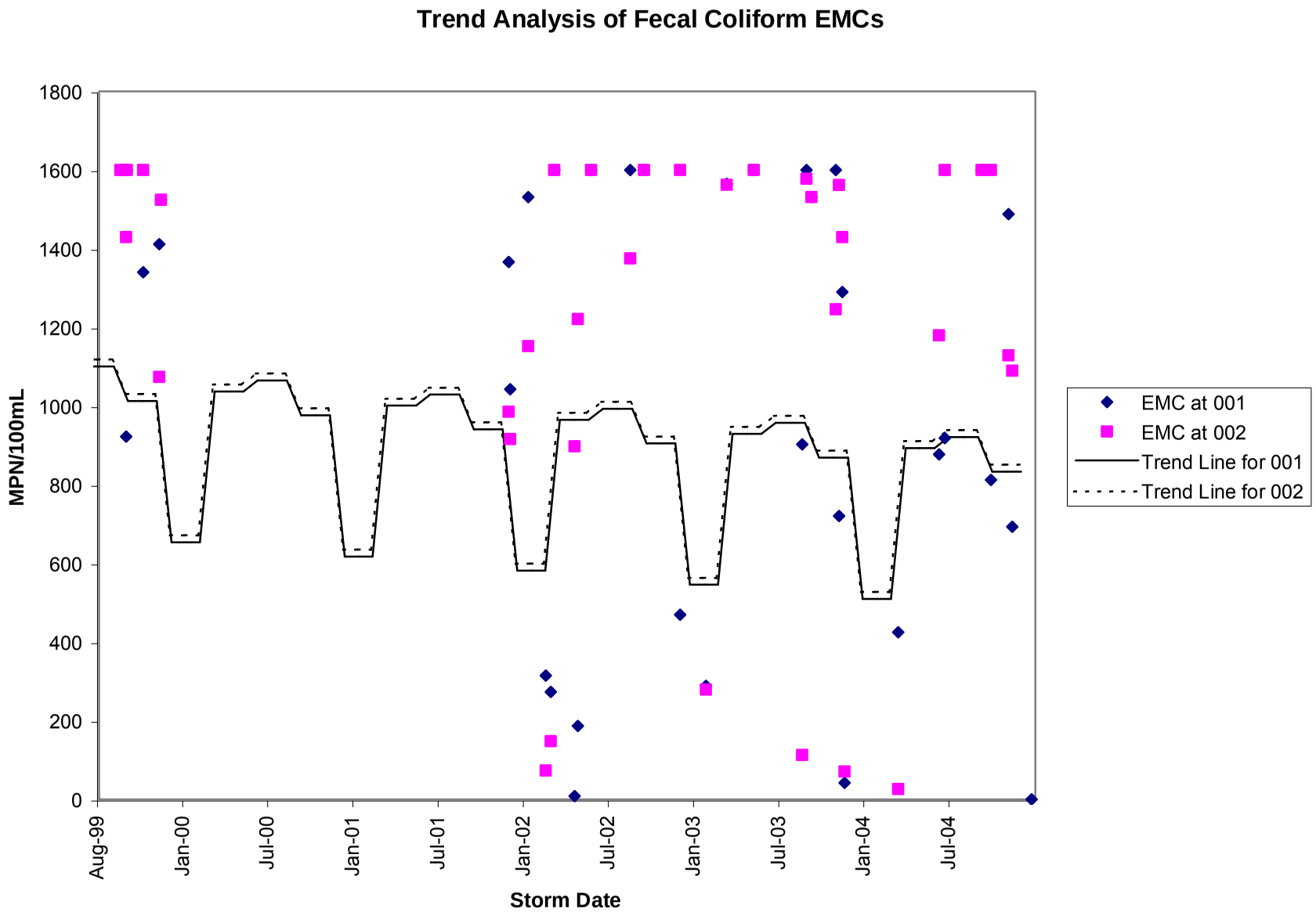
Trend Analysis of Total Phenol EMCs



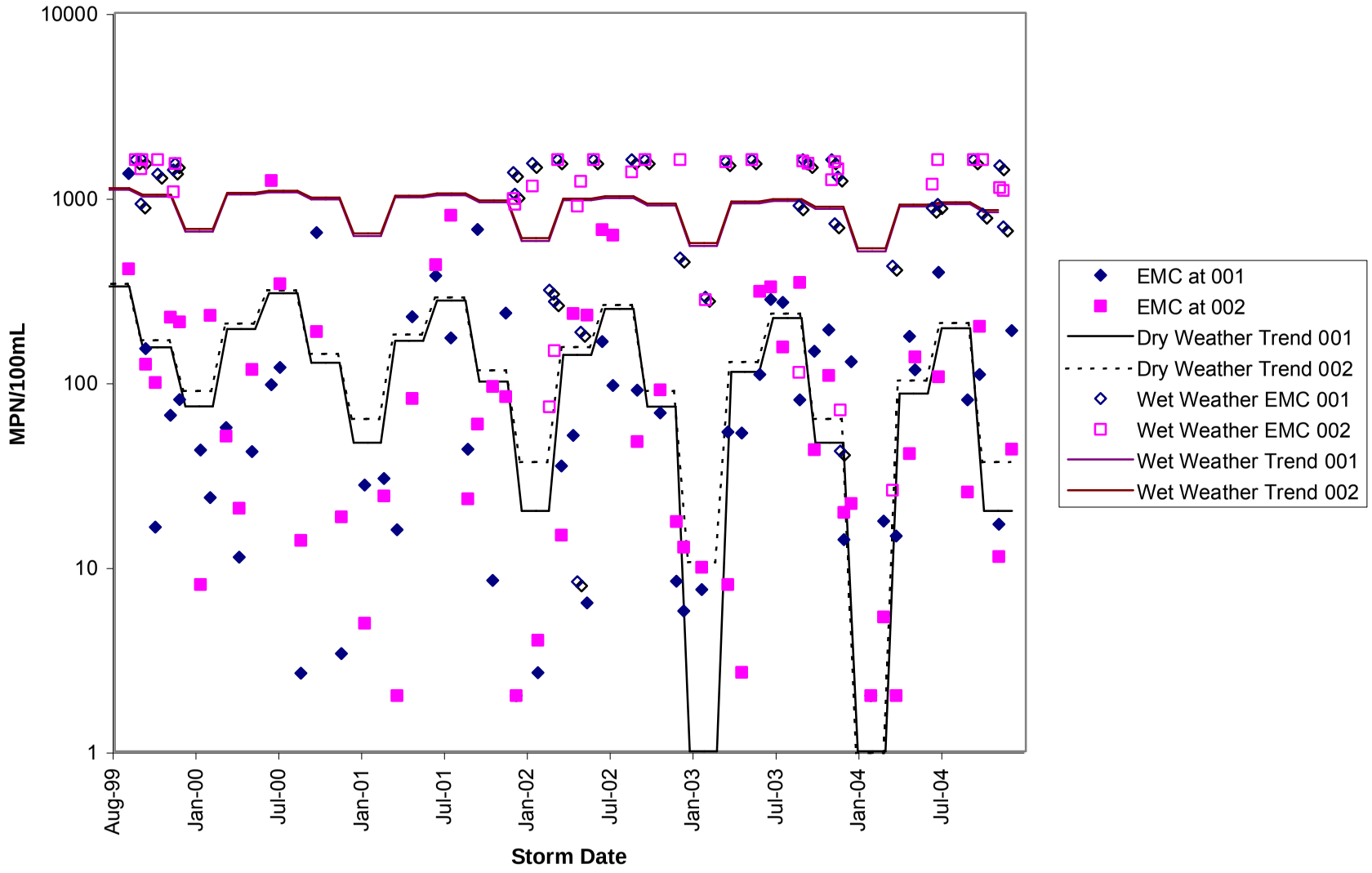

Trend Analysis of Copper EMCs
Event 0198S
30 June 1998
EMC (mg/L)
0.03
0.025
0.02
0.015
0.01
0.005
0
Jul-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002


Trend Analysis of Lead EMCs
EMC (mg/L)
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Event 0599S
14 June 1999
non-detects
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002
Jul-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date


Trend Analysis of Zinc EMCs
Event 0198S
30 July 1998
EMC (mg/L)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Jan-98
Jun-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
May-04
Nov-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002


Trend Analysis of Fecal Coliform EMCs
MPN/100mL
1800
1600
1400
1200
1000
800
600
400
200
0
Aug-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Storm Date
EMC at 001
EMC at 002
Trend Line for 001
Trend Line for 002

Trend Analysis of Fecal Coliform during Wet and Dry Weather Conditions



Appendix C
Watershed Profiles

Maryland's Surf Your Watershed - Watershed Profile

Aberdeen Proving Ground

WATERSHED INFORMATION

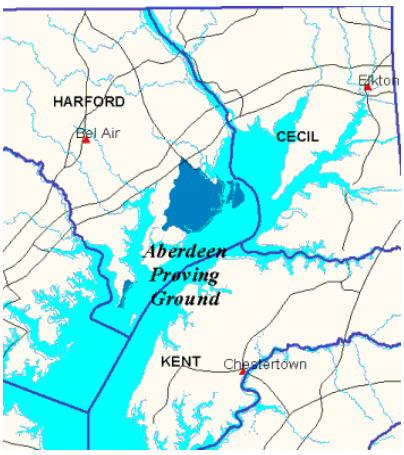
Maryland 8-Digit Watershed Code:	**02130705**
Tributary Basin:	**UPPER WESTERN SHORE**

Population (1990 US Census)

1990 Est. Population Density (Ppl per ac)	**0.87**

1994 Land Use (MdOP Data)

Urban Acres	**8,253**
Agricultural Acres	**224**
Forest Acres	**8,460**
Wetland Acres	**3,042**
Barren Acres	**0**
Total Acres (non-water)	**19,979**



NON-TIDAL WETLAND REGULATORY ACTIONS

Authorizations by Type (since 1991)

Letter of Authorization
Permit
Emergency Permit
Authorization to Proceed

Wetland Impact Data (since 1991)

Acres of Permanent Loss	**-0.1**
Acres of Permitted Mitigation	
Acres of Programmatic Gains	
Acres of Other Gains	
Net Gain/Loss	**-0.1**

WATERSHED INDICATORS

Restoration Indicators	Indicator Value	Failed Indicator
Water Quality		
Monitored Nutrient Concentrations		
- eutrophication		
- habitat		
Modeled Nitrogen Loading Rate per ac. (lbs.)	**9.32**	
Modeled Phosphorus Loading Rate per ac. (lbs.)	**0.32**	
Aquatic Living Resources		
SAV Abundance		
SAV Habitat		
Tidal Benthic Index of Biotic Integrity		
Tidal Fish Index of Biotic Integrity		
Anadromous Fish Index		
Non-Tidal Benthic Index of Biotic Integrity	**2.57**	
Non-Tidal Fish Index of Biotic Integrity		
Non-Tidal Instream Habitat Index		
Landscape Parameters		
Percent Impervious Surface	**31.5**	Yes
Population Density (people per land acre)	**0.87**	
Historic Wetland Loss (acres)	**258**	
Percent Unforested Stream Buffer	**26**	
Soil Erodibility	**0.01**	
Clean Water Requirements		
303d List	**2**	Yes

Protection Indicators	Indicator Value	Select Indicator
Aquatic Living Resources		
Tidal Fish Index of Biotic Integrity		
Non-Tidal Instream Habitat Index		
Non-Tidal Fish Index of Biotic Integrity		
Imperiled Aquatic Species Indicator	**0**	
Migratory Fish Spawning Area	**4**	Yes
Anadromous Fish Index		
Wetland-Dependent Species	**0.0**	
Trout Spawning Area		
Fish Hatchery Water Supply		
Landscape Parameters		
% Headwater Streams occurring in Interior Forest	**18**	
Percent Watershed Forested	**46**	
Wildland Acres	**0**	
Number of Drinking Water Intakes	**0**	
Wetlands Acres of Special Concern	**0**	

Unified Watershed Assessment Categorization

Priority Category 1 (Does Not Meet Clean Water or Natural Resource Goals)	**No**
Priority Category 2 (Meets Clean Water or Natural Resource Goals)	**No**
Select Category 3 (Need for Special Protection of Natural Resources)	**No**

Maryland's Surf Your Watershed - Watershed Profile

Bynum Run

WATERSHED INFORMATION

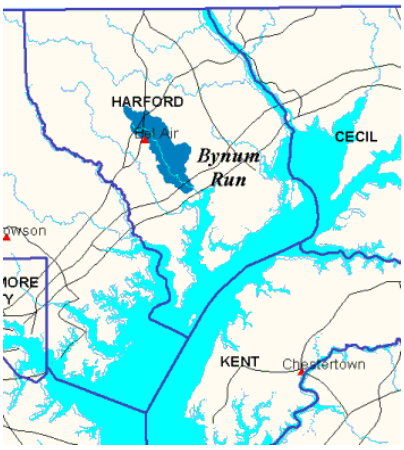
Maryland 8-Digit Watershed Code:	**02130704**
Tributary Basin:	**UPPER WESTERN SHORE**

Population (1990 US Census)

1990 Est. Population Density (Ppl per ac)	**0.81**

1994 Land Use (MdOP Data)

Urban Acres	**6,858**
Agricultural Acres	**5,521**
Forest Acres	**2,011**
Wetland Acres	**0**
Barren Acres	**176**
Total Acres (non-water)	**14,566**



NON-TIDAL WETLAND REGULATORY ACTIONS

Authorizations by Type (since 1991)

Letter of Authorization	**3**
Permit	**3**
Emergency Permit	
Authorization to Proceed	

Wetland Impact Data (since 1991)

Acres of Permanent Loss	**-4.4**
Acres of Permitted Mitigation	**3.1**
Acres of Programmatic Gains	
Acres of Other Gains	
Net Gain/Loss	**-1.2**

WATERSHED INDICATORS

Restoration Indicators	Indicator Value	Failed Indicator
Water Quality		
Monitored Nutrient Concentrations		
- eutrophication		
- habitat		
Modeled Nitrogen Loading Rate per ac. (lbs.)	**10.94**	Yes
Modeled Phosphorus Loading Rate per ac. (lbs.)	**0.47**	
Aquatic Living Resources		
SAV Abundance		
SAV Habitat		
Tidal Benthic Index of Biotic Integrity		
Tidal Fish Index of Biotic Integrity		
Anadromous Fish Index		
Non-Tidal Benthic Index of Biotic Integrity	**4.3**	
Non-Tidal Fish Index of Biotic Integrity	**8.3**	
Non-Tidal Instream Habitat Index	**6.01**	
Landscape Parameters		
Percent Impervious Surface	**21.1**	Yes
Population Density (people per land acre)	**0.81**	
Historic Wetland Loss (acres)	**3,321**	
Percent Unforested Stream Buffer	**70**	Yes
Soil Erodibility	**0.34**	Yes
Clean Water Requirements		
303d List	**2**	Yes

Protection Indicators	Indicator Value	Select Indicator
Aquatic Living Resources		
Tidal Fish Index of Biotic Integrity		
Non-Tidal Instream Habitat Index	**6.01**	
Non-Tidal Fish Index of Biotic Integrity	**8.3**	Yes
Imperiled Aquatic Species Indicator	**0**	
Migratory Fish Spawning Area	**0**	
Anadromous Fish Index		
Wetland-Dependent Species	**0.0**	
Trout Spawning Area	**0.0**	
Fish Hatchery Water Supply		
Landscape Parameters		
% Headwater Streams occurring in Interior Forest	**1**	
Percent Watershed Forested	**33**	
Wildland Acres	**0**	
Number of Drinking Water Intakes	**0**	
Wetlands Acres of Special Concern	**0**	

Unified Watershed Assessment Categorization

Priority Category 1 (Does Not Meet Clean Water or Natural Resource Goals)	**Yes**
Priority Category 2 (Meets Clean Water or Natural Resource Goals)	**No**
Select Category 3 (Need for Special Protection of Natural Resources)	**No**

Maryland's Surf Your Watershed - Watershed Profile

Lower Winters Run

WATERSHED INFORMATION

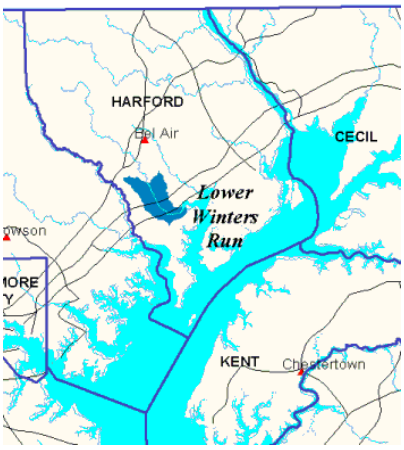
Maryland 8-Digit Watershed Code:	**02130702**
Tributary Basin:	**UPPER WESTERN SHORE**

Population (1990 US Census)

1990 Est. Population Density (Ppl per ac)	**0.81**

1994 Land Use (MdOP Data)

Urban Acres	**3,142**
Agricultural Acres	**1,805**
Forest Acres	**3,311**
Wetland Acres	**144**
Barren Acres	**0**
Total Acres (non-water)	**8,402**



NON-TIDAL WETLAND REGULATORY ACTIONS

Authorizations by Type (since 1991)

Letter of Authorization	**1**
Permit	
Emergency Permit	
Authorization to Proceed	

Wetland Impact Data (since 1991)

Acres of Permanent Loss	**-3.4**
Acres of Permitted Mitigation	**8.4**
Acres of Programmatic Gains	
Acres of Other Gains	
Net Gain/Loss	**5.0**

WATERSHED INDICATORS

Restoration Indicators	Indicator Value	Failed Indicator
Water Quality		
Monitored Nutrient Concentrations		
- eutrophication		
- habitat		
Modeled Nitrogen Loading Rate per ac. (lbs.)	**11.54**	Yes
Modeled Phosphorus Loading Rate per ac. (lbs.)	**0.38**	
Aquatic Living Resources		
SAV Abundance		
SAV Habitat		
Tidal Benthic Index of Biotic Integrity		
Tidal Fish Index of Biotic Integrity		
Anadromous Fish Index		
Non-Tidal Benthic Index of Biotic Integrity	**3.71**	
Non-Tidal Fish Index of Biotic Integrity	**8.0**	
Non-Tidal Instream Habitat Index	**6.43**	
Landscape Parameters		
Percent Impervious Surface	**18.3**	Yes
Population Density (people per land acre)	**0.81**	
Historic Wetland Loss (acres)	**3,102**	
Percent Unforested Stream Buffer	**34**	
Soil Erodibility	**0.33**	Yes
Clean Water Requirements		
303d List	**0**	

Protection Indicators	Indicator Value	Select Indicator
Aquatic Living Resources		
Tidal Fish Index of Biotic Integrity		
Non-Tidal Instream Habitat Index	**6.43**	
Non-Tidal Fish Index of Biotic Integrity	**8.0**	
Imperiled Aquatic Species Indicator	**6**	Yes
Migratory Fish Spawning Area	**2**	Yes
Anadromous Fish Index		
Wetland-Dependent Species	**0.0**	
Trout Spawning Area	**0.0**	
Fish Hatchery Water Supply		
Landscape Parameters		
% Headwater Streams occurring in Interior Forest	**8**	
Percent Watershed Forested	**41**	
Wildland Acres	**0**	
Number of Drinking Water Intakes	**1**	Yes
Wetlands Acres of Special Concern	**0**	

Unified Watershed Assessment Categorization

Priority Category 1 (Does Not Meet Clean Water or Natural Resource Goals)	**No**
Priority Category 2 (Meets Clean Water or Natural Resource Goals)	**No**
Select Category 3 (Need for Special Protection of Natural Resources)	**No**